DOCUMENT RESUME

ED 325 697 CE 056 282

AUTHOR	Sloan, Garry
TITLE	Electrical Procedures and Environmental Control Systems. Building Maintenance. Module IV. Instructor's Guide.
INSTITUTION	Missouri Univ., Columbia. Instructional Materials Lab.
SPONS AGENCY	Missouri State Dept. of Elementary and Secondary Education, Jefferson City. Div. of Vocational and Adult Education.
PUB DATE	Mar 90
NOTE	254p.; For related modules, see ED 315 656 and CE 056 280-284.
AVAILABLE FROM	Instructional Materials Laboratory, University of Missouri, 2316 Industrial Drive, Columbia, MO 65202 (order no. 70-2304-I: $17.30; set of six, order no. 70-2300-I: $109.15).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Air Conditioning; Air Conditioning Equipment; Behavioral Objectives; *Buildings; Building Trades; Competency Based Education; *Electrical Systems; *Electricians; Electricity; Electric Motors; *Heating; Job Skills; Learning Activities; Lighting; *Maintenance; Repair; Secondary Education; State Curriculum Guides; Thermal Environment; Trade and Industrial Education
IDENTIFIERS	Missouri

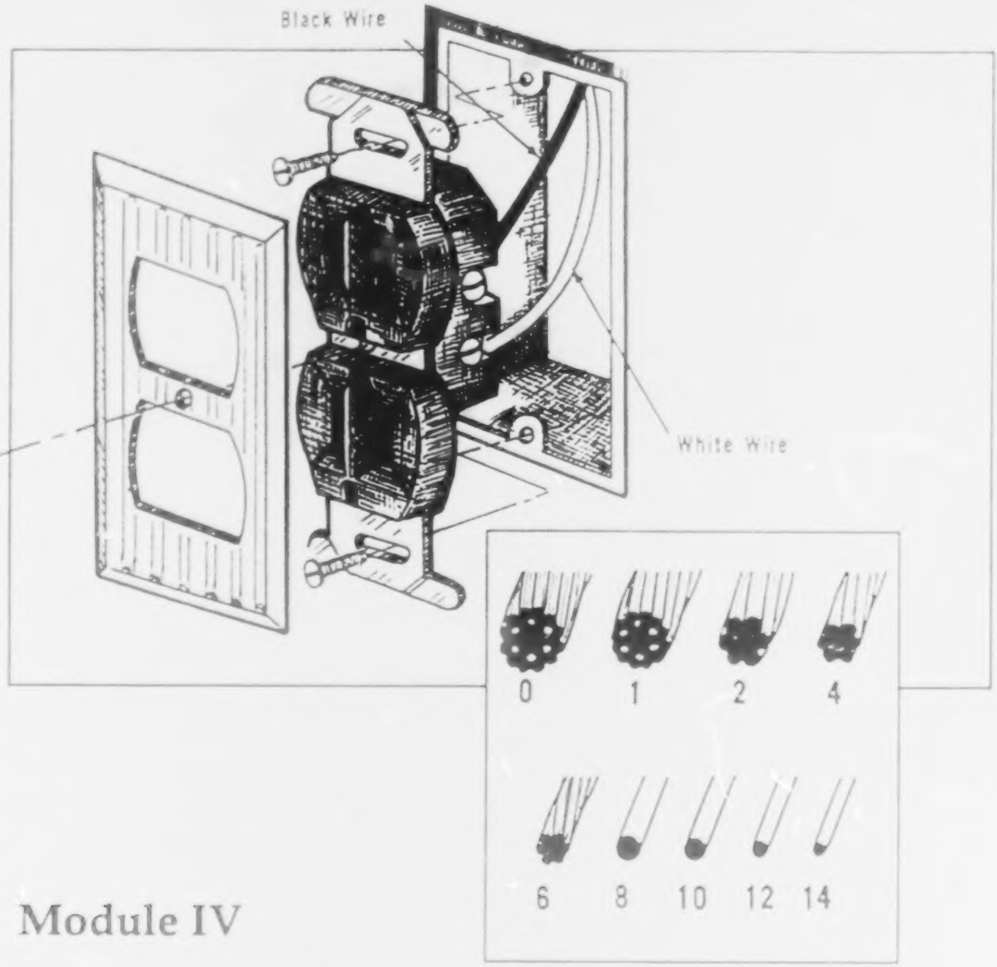
ABSTRACT

This curriculum guide, one of six modules keyed to the building maintenance competency profile developed by industry and education professionals, provides materials for two units on electrical procedures and environmental control systems. Unit 1, on electrical procedures, includes the following lessons: electrical safety; troubleshooting and replacing outlets, switches, fuses, breakers, and fixtures; cut, ream, bend, and connect conduit; wiring circuits; low-voltage wiring; using electronic test equipment; and making minor repairs and changing light bulbs. In unit 2, which deals with servicing environmental control systems, are the following lessons: adjust/replace belts; electric motors; clean/replace heating elements--gas; clean/replace heating elements--electric; clean condensing unit; clean evaporator coil; check and clean flues; and replace furnace and cooling filter. Each lesson includes some or all of the following color-coded components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets, lesson tests, and answer key. (YLB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED325697

70-2304-I
Instructor's Guide



U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

Module IV

Electrical Procedures and Environmental Control Systems

BUILDING MAINTENANCE

Produced by Instructional Materials Laboratory
In cooperation with the Department of Elementary
And Secondary Education

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)"

CE 056 282

Modules in this IML Building Maintenance series:

Orientation to Building Maintenance

Carpentry and Finishing Procedures

Plumbing Procedures

Electrical Procedures and Environmental Control Systems

Masonry Procedures

Grounds Maintenance Equipment and Procedures

The activity which is the subject of this report was supported in whole or in part by funds from the Department of Elementary and Secondary Education, Division of Vocational and Adult Education. However, the opinions expressed herein do not necessarily reflect the position or policies of the Missouri Department of Elementary and Secondary Education or the Division of Vocational and Adult Education, and no official endorsement should be inferred.

BUILDING MAINTENANCE

Module IV: Electrical Procedures and Environmental Control Systems

prepared by

Garry Sloan

Produced by the Instructional Materials Laboratory
10 London Hall
University of Missouri-Columbia
Columbia, MO 65211
314/882-2884
March 1990

Instructor's Guide
Catalog No. 70-2304-I

FOREWORD

We are indebted to the teachers and administrators who have provided their time, effort and professionalism to the development of this guide. This guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. The curriculum writers and subject matter experts who worked on this guide are to be commended for a job well done.

The Vocational Instructional Management System (VIMS) has become Missouri's framework for competency-based instruction; therefore, the Building Maintenance Curriculum Guide is designed to be totally integrated with the VIMS system. A curriculum guide is more than a resource--it is an integral part of the management system. Its purpose is to guide and facilitate competency-based instruction to help classroom teachers manage instruction.

The format of this guide has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). All information sheets, transparency masters, job sheets, assignment sheets and test items are keyed to specific competencies. A cross reference table has been included to quickly identify parts of the curriculum that relate to specific competencies. The material has also been packaged for students.

Competencies are stated prior to instruction and the student knows what the basis for evaluation will be. Each student is thus held responsible for mastering the competencies. The basis for grading is attainment of competencies rather than measurement against other students.

Although this guide may be a new format and new system for many teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future building maintenance curriculum modifications will begin with this guide. We will evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

Judith Moore, Supervisor
Industrial Education
Department of Elementary and Secondary Education

Chuck Waibel, Director
Industrial Education
Department of Elementary and Secondary Education

TABLE OF CONTENTS

MODULE IV: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

Lesson 1: Electrical Safety.................................. 1
Lesson 2: Troubleshooting and Replacing Outlets, Switches Fuses, Breakers and Fixtures.................. 41
Lesson 3: Cut, Ream, Bend and Connect Conduit.............. 65
Lesson 4: Wiring Circuits to Code 115-Volt (15 and 20 Amp) and 240-Volt................................. 93
Lesson 5: Low-Voltage Wiring...............................151
Lesson 6: Using Electronic Test Equipment..................183
Lesson 7: Making Minor Repairs and Changing Light Bulbs.....213

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

Lesson 1: Adjust/Replace Belts..............................267
Lesson 2: Electric Motors...................................281
Lesson 3: Clean/Replace Heating Elements-Gas................295
Lesson 4: Clean/Replace Heating Elements-Electric...........307
Lesson 5: Clean Condensing Unit.............................317
Lesson 6: Clean Evaporator Coil.............................327
Lesson 7: Check and Clean Flues.............................337
Lesson 8: Replace a Furnace and Cooling Filter.............351

ACKNOWLEDGMENTS

This building maintenance guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the building maintenance competency profile developed by industry and education professionals in the state.

When searching for current building maintenance materials to adopt or utilize in the guide's development, comparable materials were found from the Occupational Curriculum Laboratory of East Texas State University and the Curriculum and Instructional Materials Center of Stillwater, Oklahoma. These materials have been utilized as a resource for this guide. A debt of thanks is owed to the Occupational Curriculum Laboratory and the Curriculum and Instructional Materials Center for the research and development of these building maintenance materials.

These educators contributed to the guide as members of the advisory and fieldtest committees:

Art Brunk	Fort Osage R-I AVTS, Independence, Missouri.
Virgil Crank	Arcadia Valley Vo-Tech, Ironton, Missouri.
Francis Eck	South County Technical School, St. Louis, Missouri.
Sam Hawk	Walnut Grove R-V High School, Walnut Grove, Missouri.
Judith Moore	Division of Vocational and Adult Education, Department of Elementary and Secondary Education, Jefferson City, Missouri.
Garry Sloan	Jefferson College, Hillsboro, Missouri.

Serving as technical reviewer for the guide's development was Jerry Williams, Pemiscott County Vocational School, Braggadocio, Missouri.

Instructional Materials Laboratory staff, University of Missouri-Columbia:

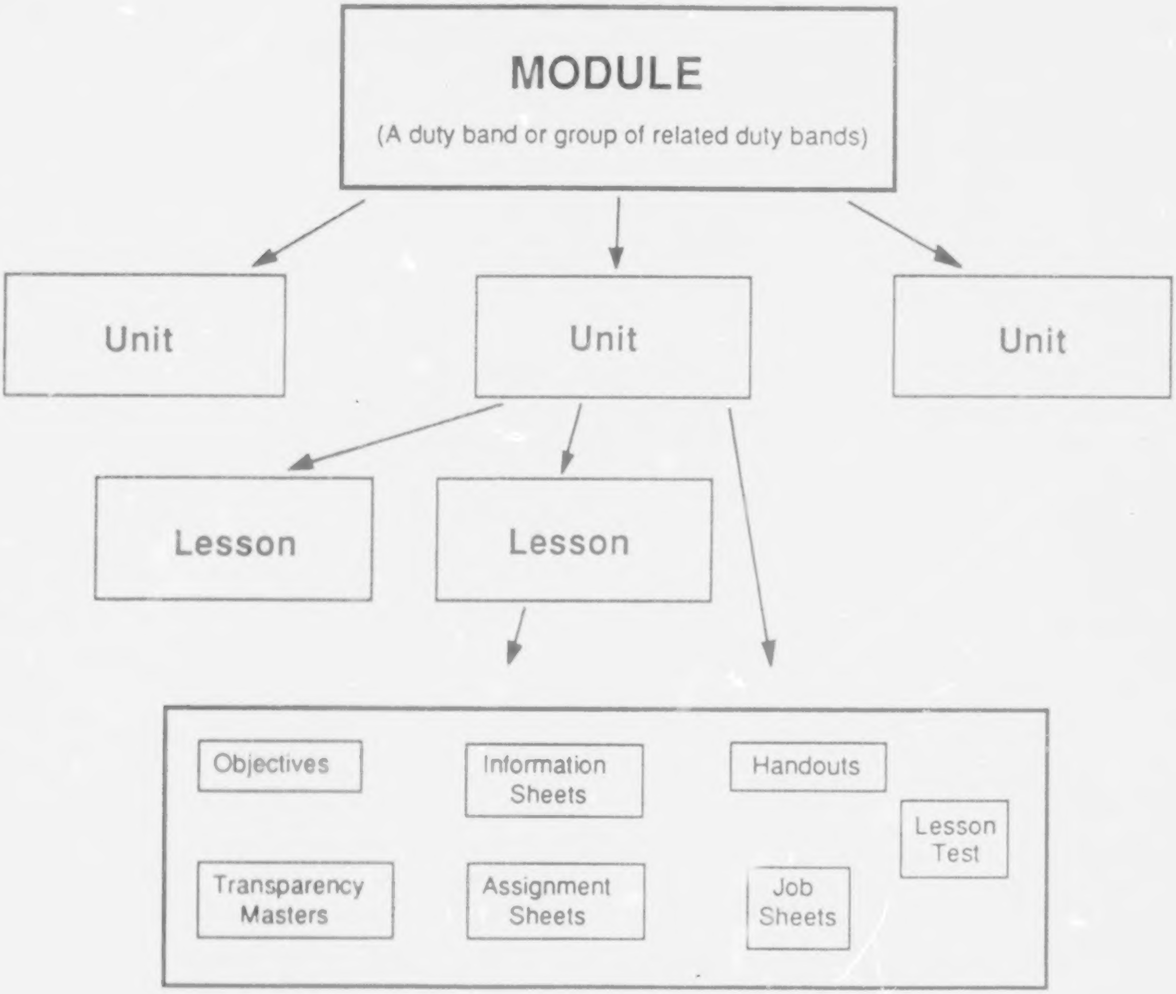
Harley Schlichting, Director
Phyllis Miller, Assistant Director
Daniel Stapleton, Assistant Director
Ann Techau, Assistant Editor
Sharon Dyer, Graphic Artist II
Angie Finks, Student Assistant
Betty Gibb, Project Writer
Lori Holliday, Word Processor Operator III

HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of Instruction

This Building Maintenance guide contains six modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and lesson tests.


MODULE
(A duty band or group of related duty bands)
Unit
Unit
Unit
Lesson
Lesson
Objectives
Information Sheets
Handouts
Lesson Test
Transparency Masters
Assignment Sheets
Job Sheets

Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student's performance of the competencies, a 3-2-1-N grading system is used where:

3 = **Mastery**--can work independently with no supervision
2 = **Requires supervision**--can perform job completely with limited supervision
1 = **Not mastered**--requires further instruction and close supervision
N = **No exposure**--no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc). Other components of the module (transparencies, handouts, assignment sheets and job sheets) are shown with Arabic numerals. By looking at the cross-reference table, the instructor can quickly determine what test questions or job sheets a student needs to receive an evaluation for on a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives which state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives and how they are intended to be used. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references (color-coded white)

These pages have been coded pink for instructor use only. The reference section lists materials used as sources in developing the material.

Information sheets (green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets.

Transparency masters (white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary and when they direct the student's attention to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion.

Handouts (white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (tan)

Assignment sheets furnish paper-and-pencil practice to develop the knowledge necessary as a prerequisite to skill development. They can be given to students for class completion or used as homework assignments. Answer sheets (color-coded pink) can be used by the student or instructor to check progress.

Job sheets (blue)

These evaluation instruments are provided for two purposes:
to outline steps of procedure and to check student performance mastery. Job sheets begin with a list of tools and materials needed for the activity. Job sheets furnish potential employers with a picture of skills being taught and performance which might be reasonably expected from a vocational student. The spaces to the right of the page on a job sheet assist the instructor in evaluating a student on a particular activity. This 3-2-1-N grading system is the same as the one used on the competency profile.

Lesson test (yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These lesson tests have been written to be used with computerized VAMS (Vocational Administrative Management System), utilizing Scantron sheets for computer-recording of test answers.

The lesson test may be eliminated if the competency was thoroughly evaluated by job sheets. However, an emphasis should be placed on cognitive as well as performance skills. If the objective or competency will be evaluated by a job sheet, it is often necessary to determine by a written test whether the student understands enough of the material to perform the job sheet.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful.

1. Provide students with objective sheet and information sheets.
2. Discus specific objectives.
3. Discuss information sheets, assignment sheets and/or job sheets, lesson-by-lesson.
4. Have students do assignment sheet(s) to satisfactory levels.
5. Give students lesson test.
6. After successful completion of the test, have students do job sheet(s).

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Do assignment sheet(s).
4. Take lesson test.
5. Do job sheets.

PACKAGING

This Building Maintenance guide has been packaged with an entire class in mind. For the teacher, a complete instructor's guide contains all six modules. In the student reference, selected portions have been reproduced for student use (objectives, information sheets, handouts). Student work sheets (assignment sheets, job sheets, lesson tests) have been packaged together for student distribution as the instructor deems necessary.

In the student reference, page numbers do not run consecutively because some pages have been removed that appear only in the instructor's guide.

Building Maintenance

Module: Electrical Procedures

Cross-Reference Table of Instructional Materials

Competency	Unit	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
D-1	I	1.1-1.6	1-11				1-72	
D-2	I	2.1-2.7				1-5	1-12	
D-3	I	3.1-3.7	1			1-5	1-12	
D-4	I	4.1-4.17	1-8		1,2	1-8	1-51	
D-5	I	5.1-5.10	1,2			1,2	1-15	
D-6	I	6.1-6.7	1,2		1	1-5	1-12	
D-7	I	7.1-7.10	1-9		1,2	1-6	1-30	
G-1	II	1.1-1.4	1-3			1		
G-2	II	2.1	1,2			1		
G-3	II	3.1-3.5				1	1-6	
G-3	II	4.1-4.3	1			1		
G-4	II	5.1-5.2	1			1		
G-5	II	6.1-6.2	1			1		
G-6	II	7.1-7.4	1,2			2		
G-7	II	8.1-8.3	1,2			1		

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 1: ELECTRICAL SAFETY

LESSON OBJECTIVE

After completion of this lesson, the student will be able to IDENTIFY SAFETY SIGNS AND PROCEDURES INVOLVED IN WORKING SAFELY WITH ELECTRICITY. Mastery will be evidenced by scoring__________ percent on the lesson test.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Match terms associated with electrical safety to the correct definitions.
2. Match safety signs or tags to their correct color codes.
3. State the two major causes of electrical accidents.
4. Select basic electrical safety practices.
5. List four electrical fire prevention practices.
6. Select safe practices for step ladders.
7. List four safety practices for job-built and extension ladders.
8. Select safe practices for manual hand tools.
9. List safety practices for electrical hand tools.
10. Distinguish between proper and improper dress for electrical work.
11. List three proper lifting techniques.
12. List three facts about the importance of the third wire.
13. Discuss ground fault interrupters.
14. Distinguish between safe and unsafe practices for working around live circuits.

15. Discuss rescue procedures in case of electrical accidents.

16. Match ampere figures at 120v, 60 hertz (cycle) to its effect on the human body.

Completion of the requirements of this lesson fulfills competency D-1 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 1: ELECTRICAL SAFETY

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
  1. Safety tag color codes
  2. Safety tag color codes (continued)
  3. Safety tag color codes (continued)
  4. Safety tag color codes (continued)
  5. Fire prevention
  6. Safety practices for step ladders
  7. Safe ladder angle
  8. Maintain tools
  9. Lifting techniques
  10. Rescue procedures
  11. Rescue procedures (continued)

D. Lesson test

E. Answers to lesson test

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 1: ELECTRICAL SAFETY

INFORMATION OUTLINE

I. Terms and definitions

A. Ground fault interrupter--personal protection device that stops current flow when an imbalance occurs between current-carrying conductors

B. Occupational Safety and Health Act (O.S.H.A.)--federal legislation designed to insure safe and sanitary working conditions for employees

C. Ampere--a measure of the intensity of electron flow

D. Volts--unit measure for electrical pressure

E. Hertz--one positive-to-negative change in an alternating current circuit

F. Multi-outlet assembly--a type of surface or flush raceway designed to hold conductors and receptacles

G. Cube tap--a device that plugs into a receptacle and provides space for connection of two or more attachment plugs

II. Color coding of safety tags or signs

A. Do not start tag (TM 1)
   1. White tag
   2. White letters on red square

B. Danger tag (TM 2)
   1. White tag
   2. White letters in red oval, on black square

C. Caution tag (TM 3)
   1. Yellow tag
   2. Yellow letters on black background

D. Out of order tag (TM 4)
   1. White tag
   2. White letters on black background

III. Major causes of electrical accidents

- A. Carelessness
- B. Misuse

IV. Basic electrical safety practices

- A. Never underestimate the danger of 110v AC circuits

  (Note: More people die from 110v AC electrical shock than any other voltage. This high death rate is mostly because of a lack of respect)

- B. Watch out for electrical arcs; they can cause bad burns
- C. Remember, mild shocks can cause personal injury or injury to others by your reaction
- D. Never install equipment that will overload a circuit
- E. Never bypass a fuse
- F. Be sure all current-carrying electric lines are well insulated
- G. Always check a circuit for voltage before servicing
- H. Work on live circuits only when absolutely necessary

V. Fire prevention practices (TM 5)

- A. Use extension cords only within their designated rating
- B. Never let multi-outlet assemblies or cube taps cause overloads
- C. Never use frayed or deteriorated extension cords
- D. Never tamper with fuses to change their current-carrying capacity

VI. Safe practices for step ladders (TM 6, 7)

- A. Never leave tools or equipment on footsteps or top
- B. Never stand on ladder tops
- C. Never use damaged ladders until repaired

D. Set ladders on firm, level surface

(Note: Block up legs if necessary to firm up a ladder)

E. Never use aluminum ladders in electrical work

F. If job is located in a walkway or roadway--have an attendant

VII. Safety practices for job-built and extension ladders

A: Secure top of ladder when possible

B. Make sure ladder is tall enough for the job

(Note: Top step should be platform height so that the worker can exit through rails rather than around)

C. Use nonskid feet or secure the base

D. Maintain safe ladder angle

VIII. Safe practices for manual hand tools (TM 8)

A. Never hit tempered metals such as hammer faces together

B. Watch for mushrooming effect on chisels

C. Re-bevel the heads of damaged chisels before using them

D. Watch for deterioration and breaks in wooden-handled tools

E. Use appropriate tool for the job

F. Keep sharp-edged tools sheathed or covered

IX. Safety practices for electrical hand tools

A. All tools should have proper guards

B. Don't wear loose-fitting clothing when using electrical tools

C. Use eye protection

D. Lock-on devices should not be used

E. Tools with frayed or damaged cords should not be used

F. Grounding contact should be in all cord bodies except those on double-insulated tools

X. Proper dress for electrical work

A. Do not wear loose clothing

B. Wear hard hats on all construction sites

C. Wear safety shoes

D. Wear appropriate eye protection

E. Wear hearing protection when you are subjected to continuous loud noise

F. Wear dust masks in dusty areas

XI. Proper lifting techniques (TM 9)

A. Keep back straight

B. Lift with your legs

C. Get help for heavy objects

XII. Importance of third wire

A. Installed for personal protection

B. Provides alternate path for current in case of a short

C. Stops current before severe personal injury occurs

XIII. Safety practices around live circuits

A. Use a neon test light or voltmeter to identify live circuits

B. Stand on dry surface

C. Use only one hand if possible

D. Never keep tools lying around live conductors

E. Wear suitable insulated hand covering

F. Return all tools to pouch when you are through with them

XIV. Rescue procedures (TM 10, 11)

(Note: These procedures apply to 12-240 volt locations)

A. Locate live wire and disconnect if possible

(CAUTION: Do not take hold of the person with your bare hands)

B. Decide whether it would be easier to move the person or the conductor

(CAUTION: If conductor is to be moved, use dry limb or some other nonconductive equipment--if person's body is to be moved, use several thicknesses of paper or cloth as an insulator)

C. With paper or cloth in hand, quickly pull victim free of the conductor

(Note: These decisions must be made quickly--after five minutes the chances of saving an individual decrease greatly)

XV. Amperes and their effects on the human body at 120v, 60 hertz (cycle)

A. .0005 or less amperes--no sensation

B. .0005 to .002 amperes--threshold of perception

C. .002 to .010 amperes--muscular contraction (mild to strong)

D. .005 to .025 amperes--painful shock; inability to let go

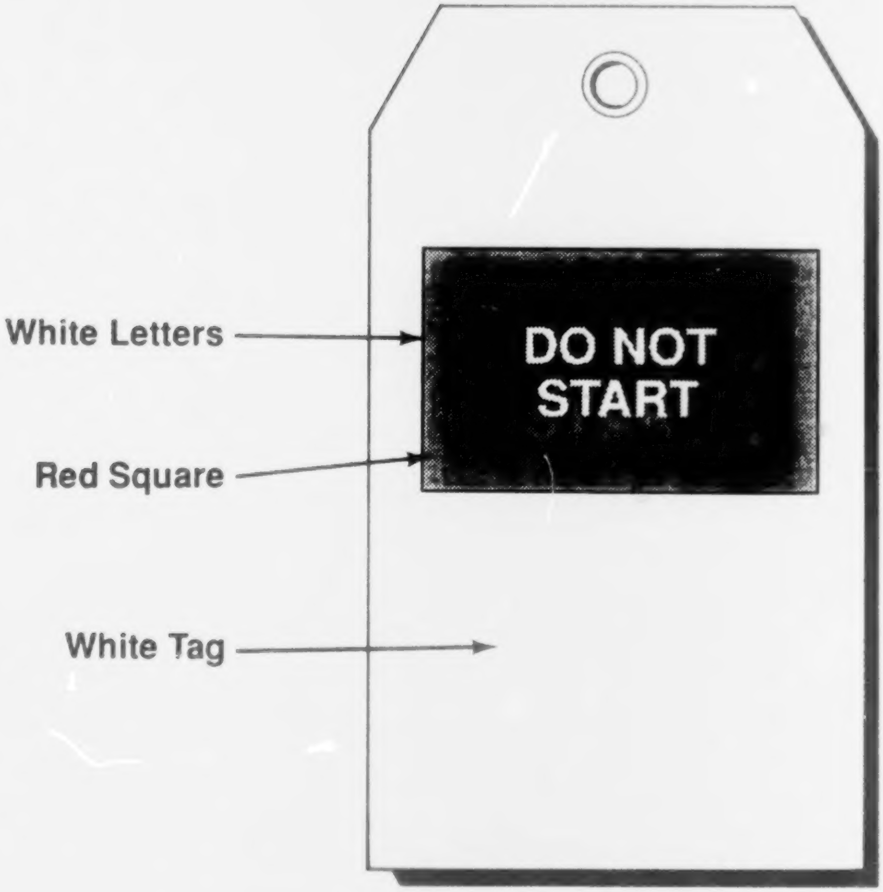
E. .025 to more amperes--violent muscular contraction

F. .050 to .200 amperes--ventricular fibrillation (convulsive movement of the heart--FATAL)

G. Over .100 amperes--paralysis of breathing (apply artificial respiration IMMEDIATELY)

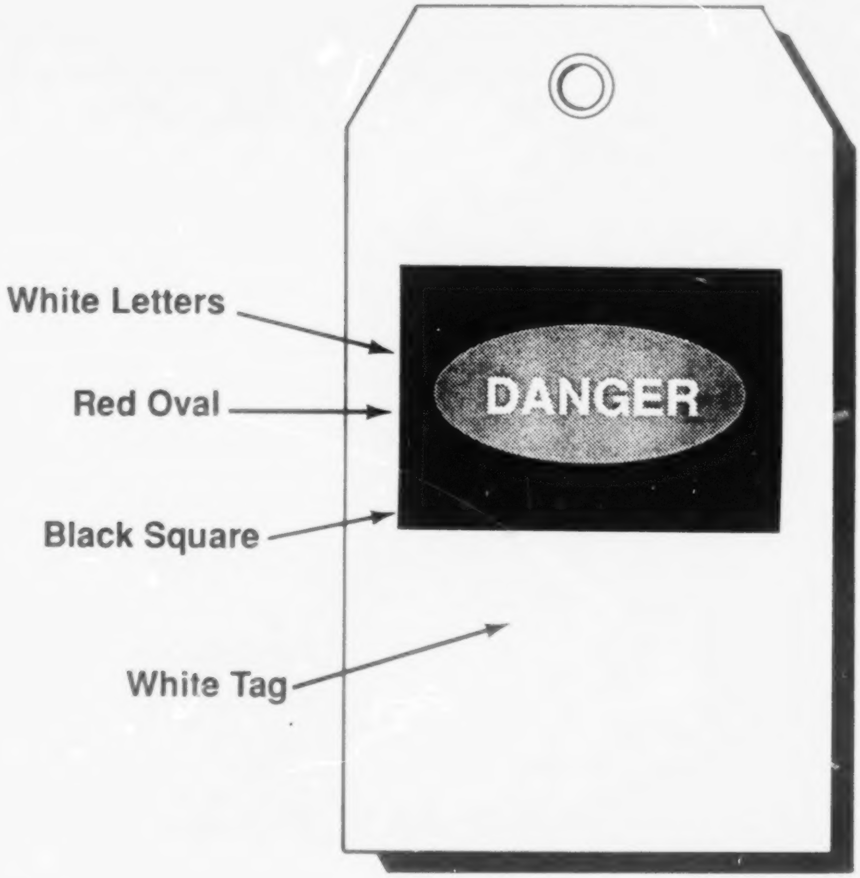
Safety Tag Color Codes

"Do Not Start" Tag


White Letters
DO NOT START
Red Square
White Tag

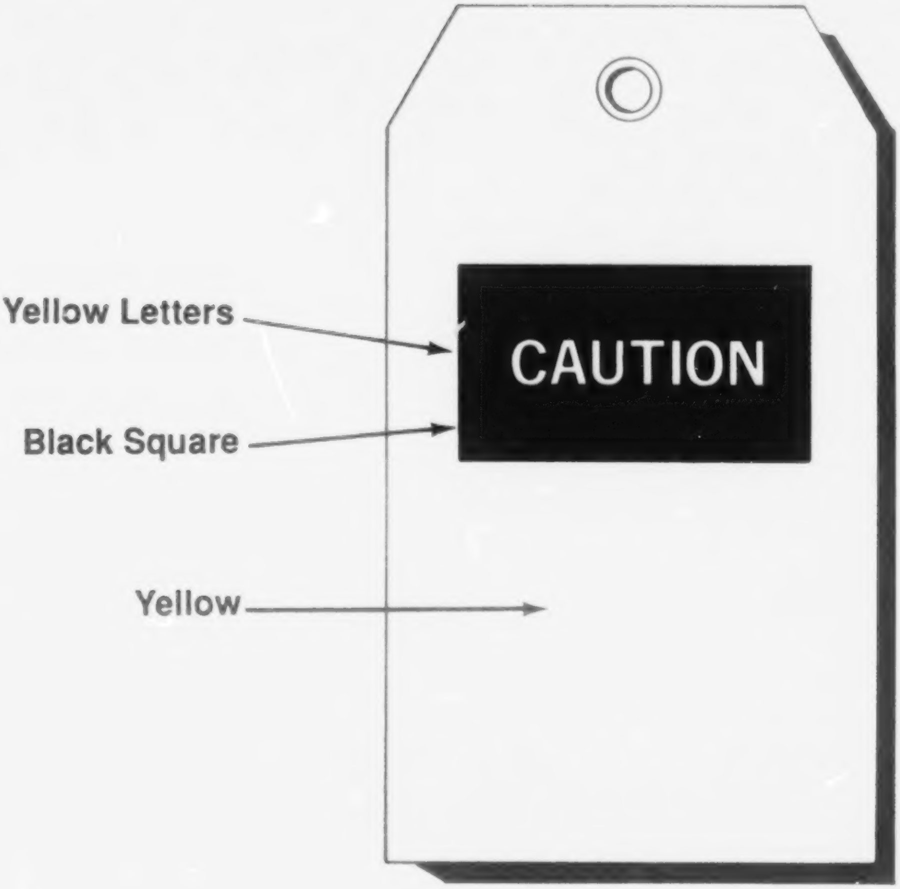
Safety Tag Color Codes (Continued)

"Danger" Tag

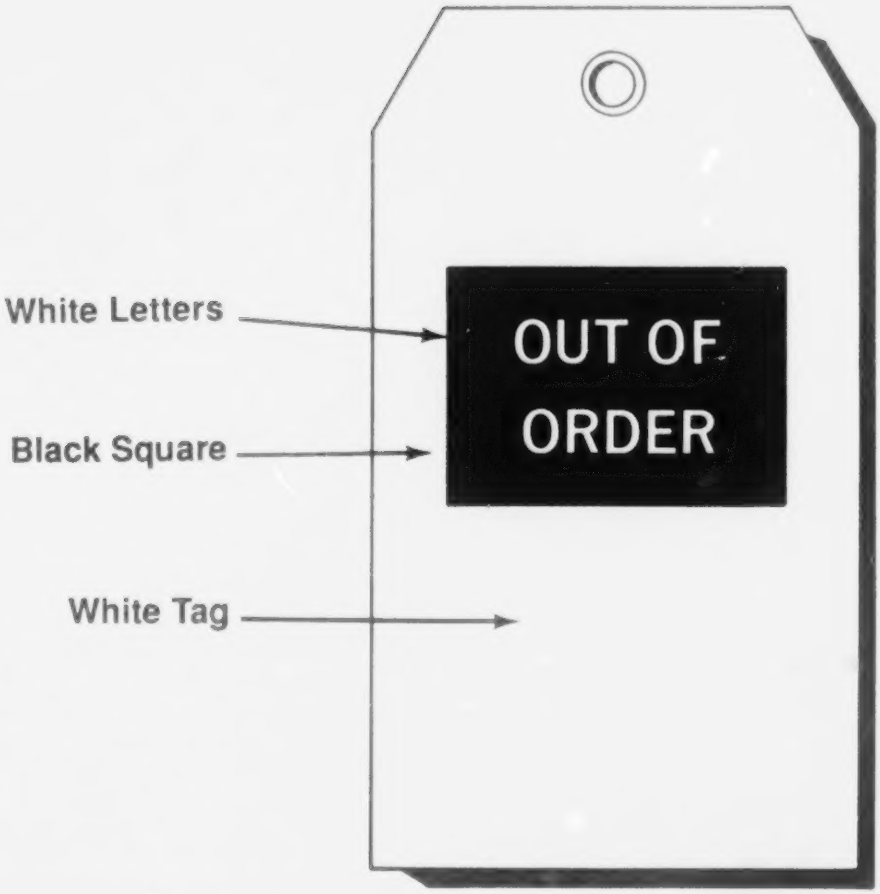

White Letters
Red Oval
Black Square
White Tag
DANGER

Safety Tag Color Codes (Continued)

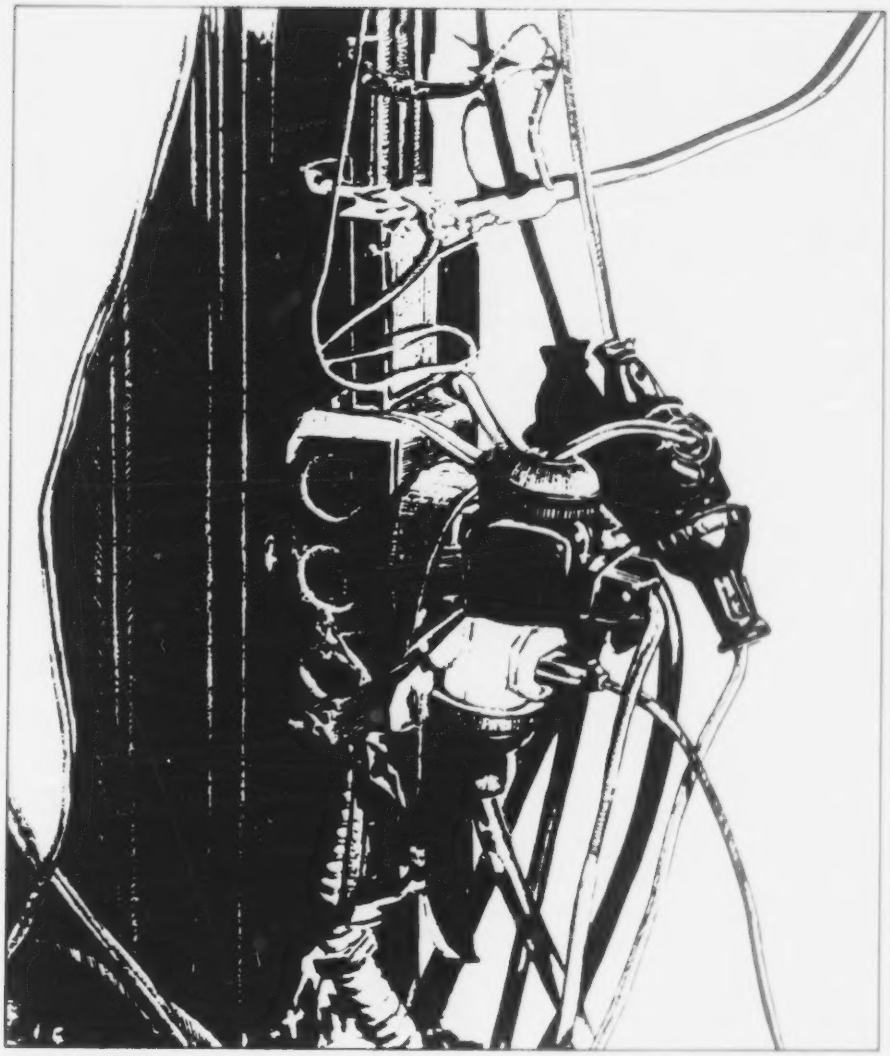
"Caution" Tag


Yellow Letters
CAUTION
Black Square
Yellow

Safety Tag Color Codes (Continued)

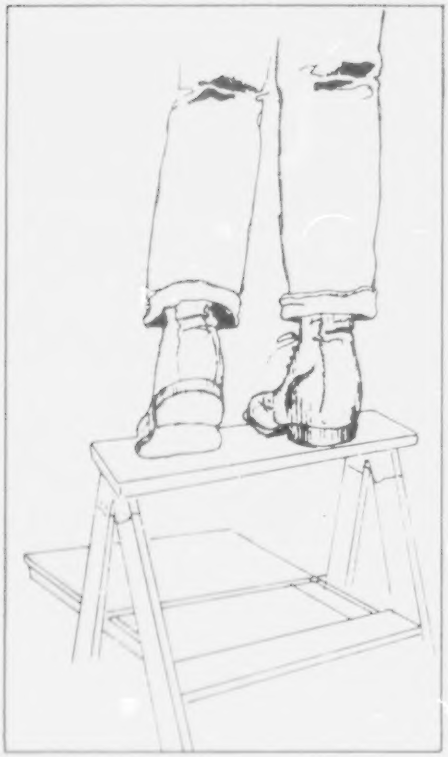

White Letters
Black Square
White Tag
OUT OF
ORDER

Fire Prevention

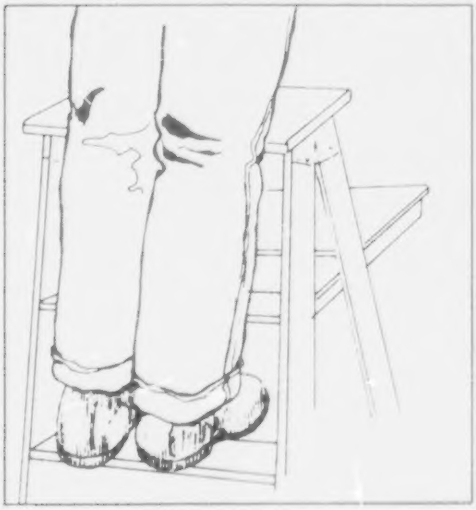


Improper use of electrical equipment is dangerous.

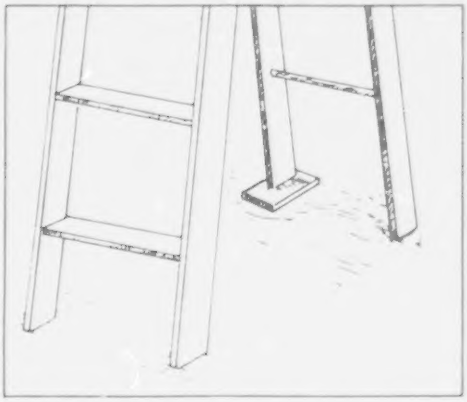
Safety Practices For Step Ladders



Incorrect



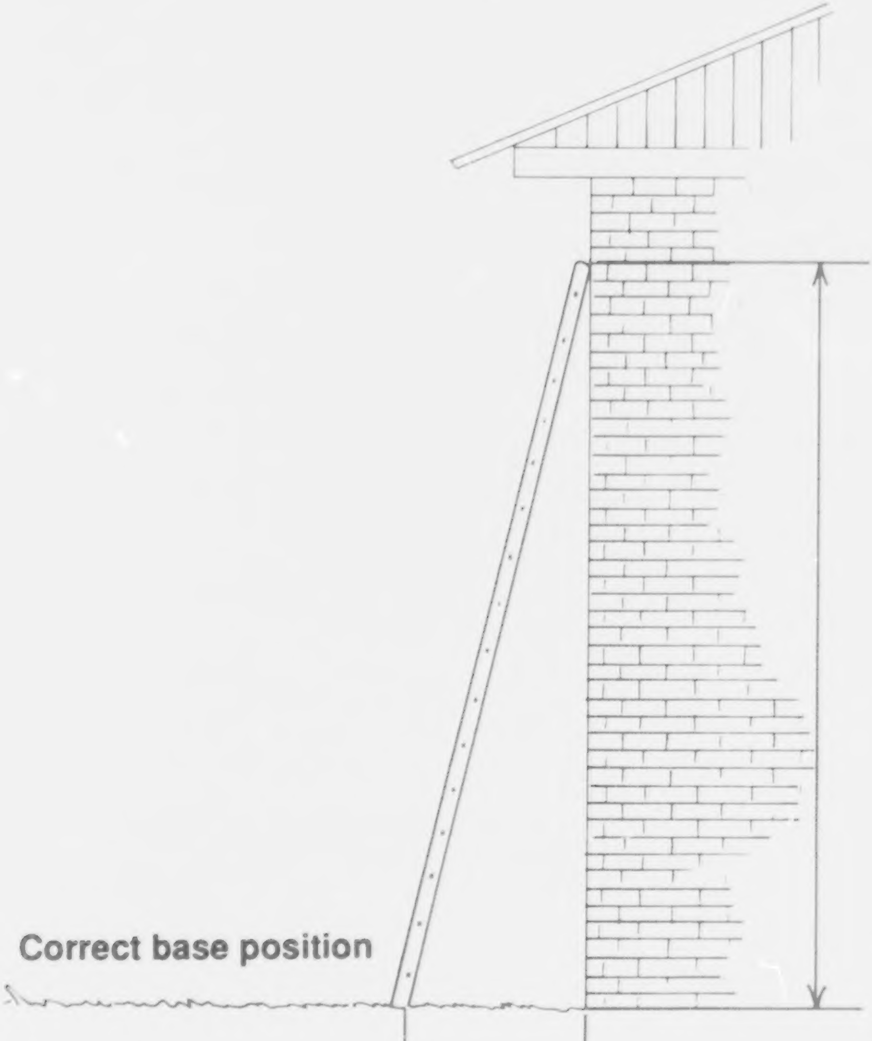
Correct



Use block to level ladder
when necessary.

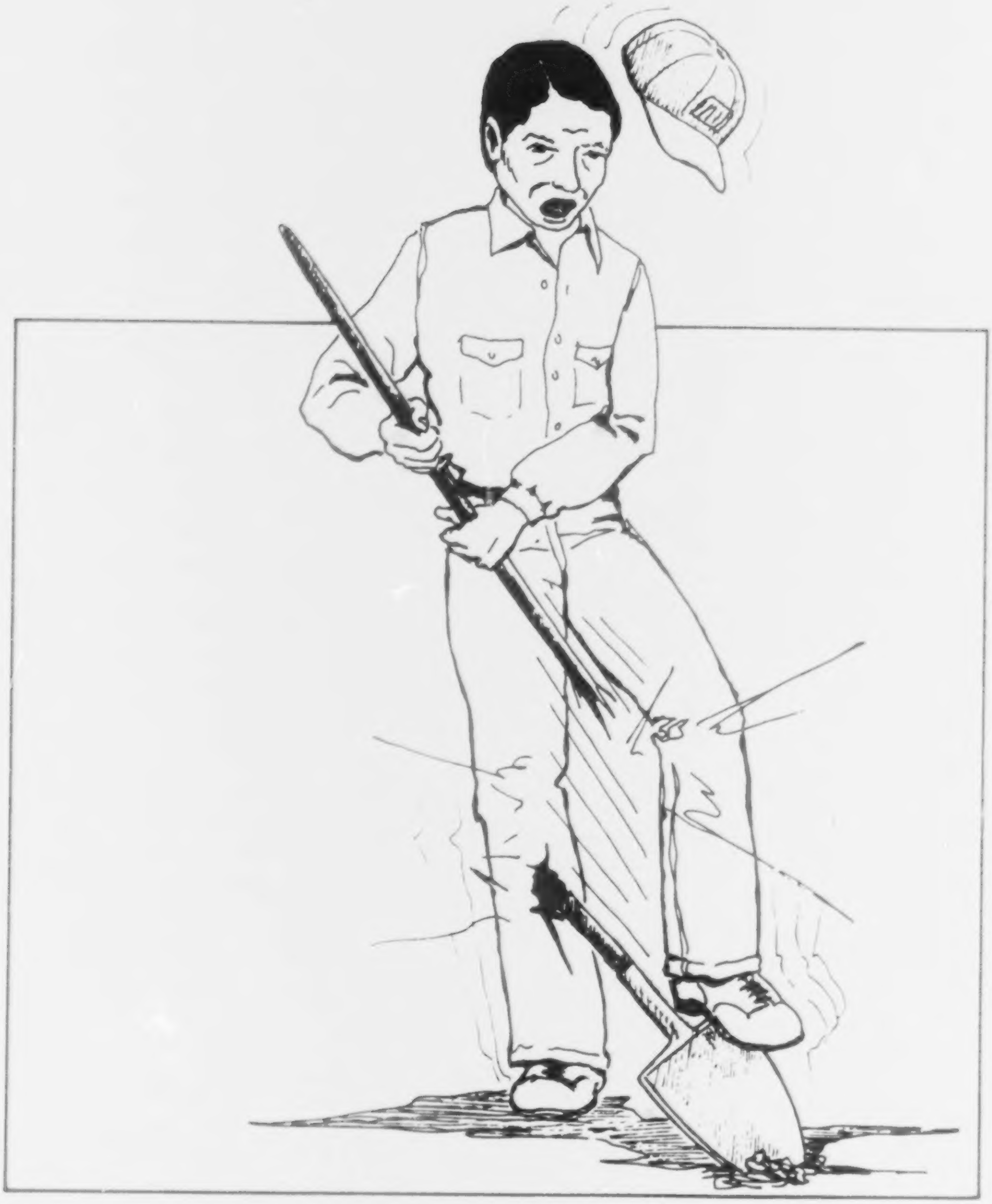
Safe Ladder Angle

Correct base position is 1/4 the vertical height


Correct base position

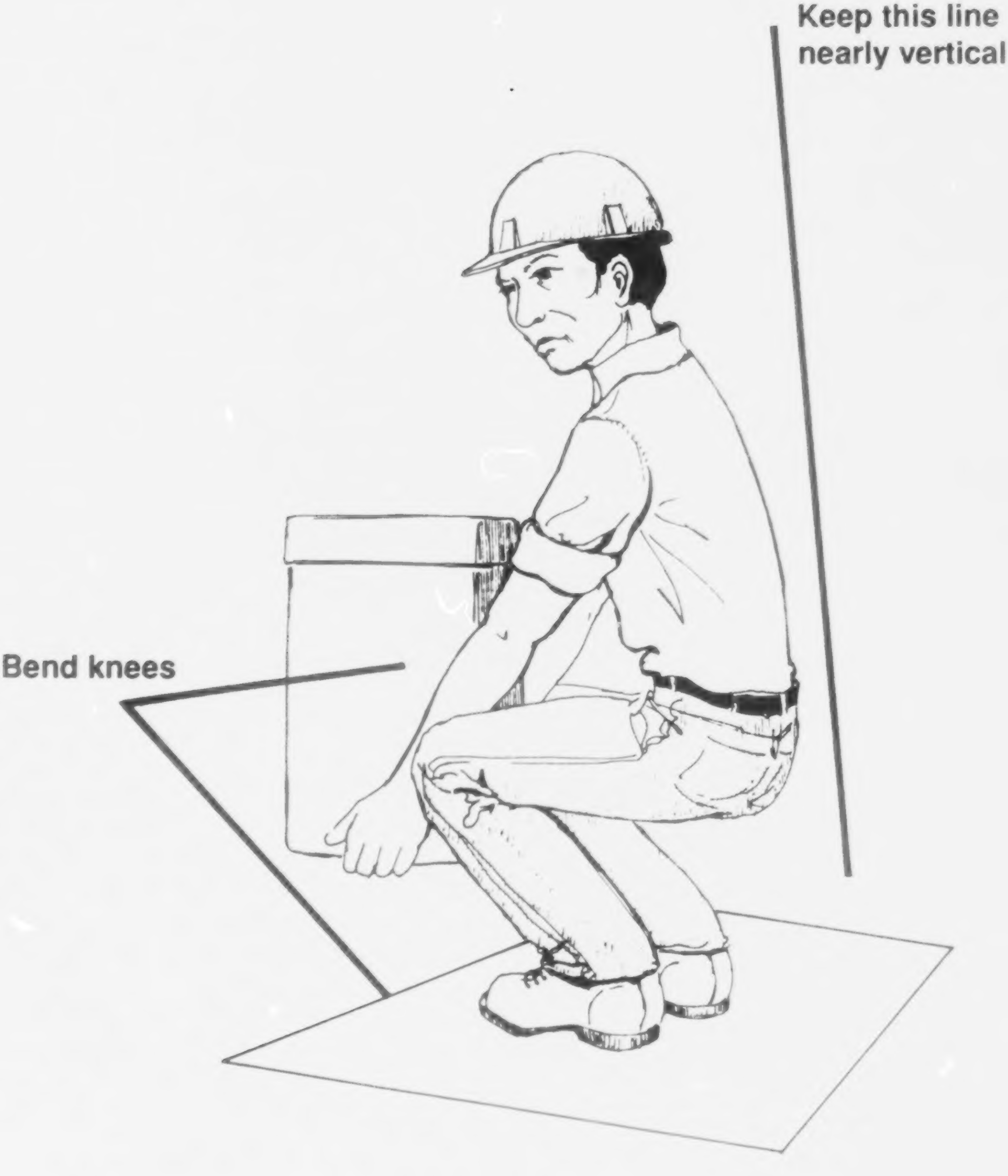
Correct base position is 1/4 the vertical height.

Maintain Tools



Faulty equipment can result in injury.

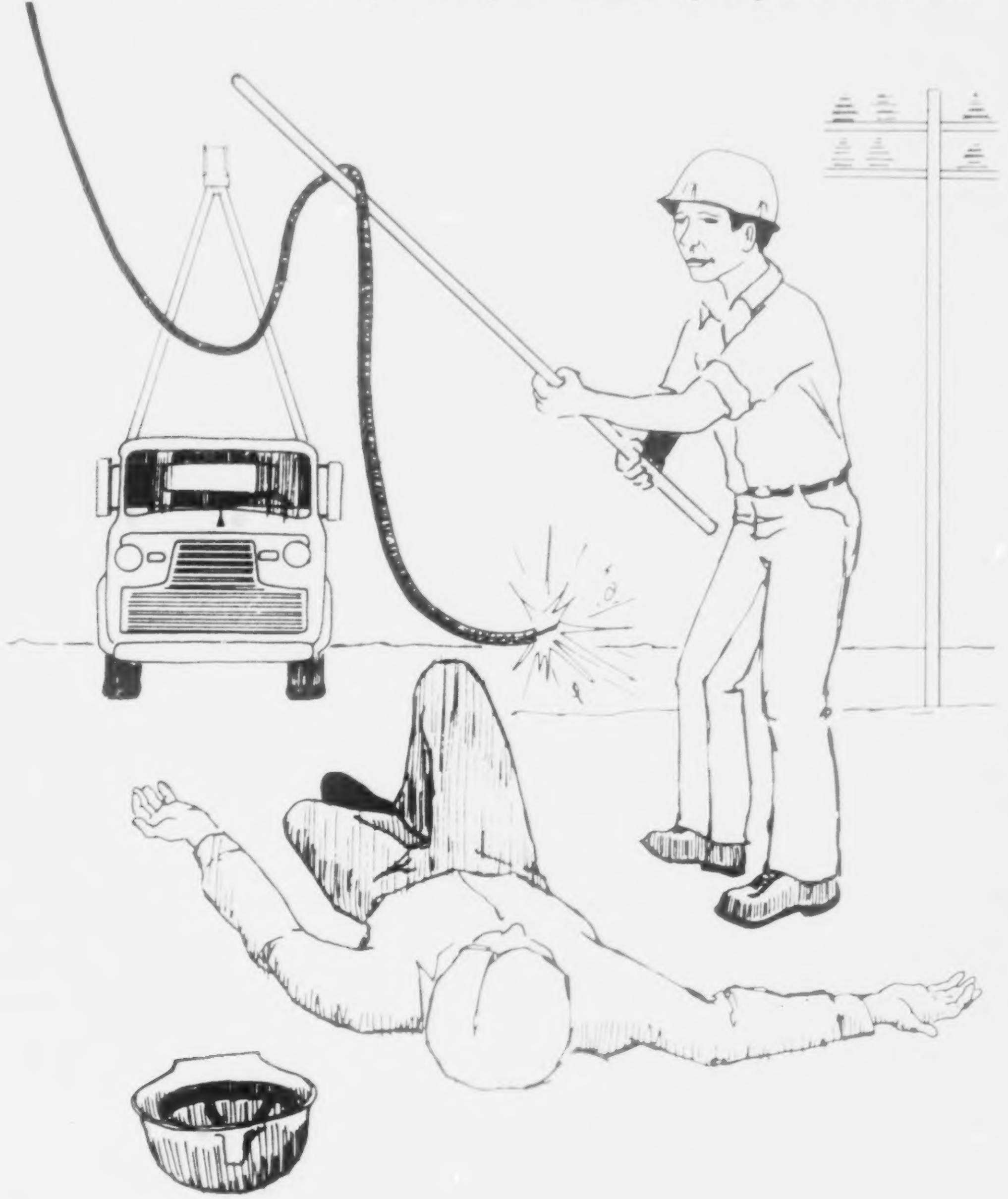
Lifting Techniques


Keep this line nearly vertical
Bend knees

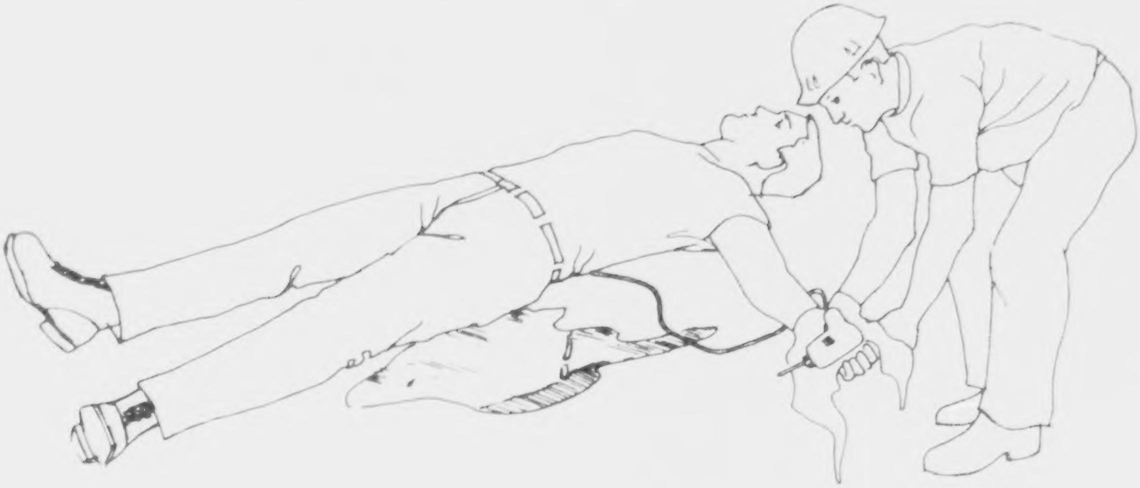
TM 10

Rescue Procedures

To remove a downed wire from a victim, use a non-conductor such as a long, dry wooden or plastic pole or a very dry tree branch.



Rescue Procedures (Continued)



Do not attempt to remove a victim without some form of insulation such as paper or cloth to protect yourself.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 1: ELECTRICAL SAFETY

LESSON TEST

Part 1. Match the terms below with the correct definitions.

A. Hertz
B. Ampere
C. Multi-outlet assembly
D. Ground fault interrupter
E. Occupational Safety and Health Act (O.S.H.A.)
AB. Volts
AC. Cube tap

_____ 1. Personal protection device that stops current flow when an imbalance occurs between current-carrying conductors

_____ 2. Federal legislation designed to insure safe and sanitary working conditions for employees

_____ 3. A measure of the intensity of electron flow

_____ 4. Unit measure for electrical pressure

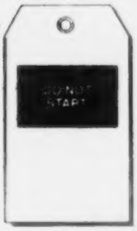
_____ 5. One positive to negative change in an alternating current circuit

_____ 6. A type of surface of flush raceway designed to hold conductors and receptacles

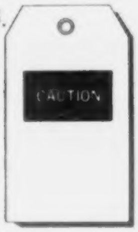
_____ 7. A device that plugs into a receptacle and provides space for connection of two or more attachment caps

Part 2. Match the following signs of tags to their correct color coding.

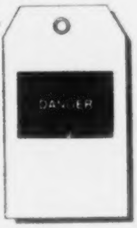
A.



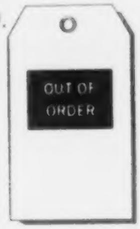
B.



C.



D.



______ 8. White tag, white letters on red square

______ 9. White tag, white letters in red oval, on black square

______10. Yellow tag, yellow letters on black background

______11. White tag, white letters on black background

Part 3. Place an "X" on the blank beside each item that is a major cause of electrical accidents.

______12. Carelessness

______13. Unexpected electrical surges

______14. Misuse

Part 4. Place an "X" on the blank beside each correct basic electrical safety practice.

______15. When you work with 110 volts, you can ignore some safety rules because the voltage is relative low

______16. Watch out for electrical arcs--they can cause bad burns

______17. Remember, mild shocks can cause personal injury or injury to others by your reaction

______18. Slight overloads are acceptable on most circuits

______19. Never bypass a fuse

______20. Always check a circuit for voltage before servicing

Part 5. Place an "X" on the blank beside each correct electrical fire prevention practice.

______21. Be sure extension cords are made of fire-retardant material

______22. Never let multi-outlet assemblies or cube taps cause overloads

______23. Wrap some tape around frayed or deteriorated extension cords before you use them

______24. Never tamper with fuses to change their current-carrying capacity

Part 6. Place an "X" on the blank beside each correct safety practice for step ladders.

______25. Never leave tools or equipment on footsteps or top

______26. Stand on ladder tops only when necessary

______27. Never use damaged ladders until repaired

______28. Be careful when using aluminum ladder for electrical work

______29. Never go to the top of a ladder set on an uneven surface

______30. Step over broken or cracked footsteps

Part 7. Place an "X" on the blank beside each correct safety practice for job-built and extension ladders.

______31. Secure the top of ladder when possible

______32. When the ladder is too short, be sure to place it on a sturdy box

______33. Use nonskid feet or secure the base

______34. As near as you can, place ladder flat against the wall

Part 8. Place an "X" on the blank beside each correct safety practice for manual hand tools.

______35. Never hit tempered metals such as hammer faces together

______36. Tape all cracked or wooden handles

______37. Re-bevel the heads of damaged chisels before using them

______38. Shovels can be used for driving wooden stakes

______39. Use appropriate tool for the job

______40. Keep sharp-edged tools sheathed or covered

Part 9. Place an "X" on the blank beside each correct safety practice for electrical hand tools.

______41. Remove all tool guards so you won't catch pieces of your clothing on them

______42. Wear loose-fitting clothing for cool comfort when working with electricity

______43. Wear eye protection only for outdoor work

______44. Be sure lock-on devices are activated on all tools

______45. Be very careful when you are using tools with frayed or damaged cords

______46. Grounding contact should be a part of only double-insulated tools

Part 10. Place an "X" on the blank beside each item of correct dress for electrical work.

______47. Ties (when working inside)

______48. Loose clothing

______49. Hard hats on all construction sites

______50. Safety shoes

______51. Appropriate eye protection

______52. Dust masks in dusty areas

Part 11. Place an "X" on the blank beside each proper lifting technique.

______53. Keep back straight

______54. Lift with your legs

______55. Get help with heavy objects

Part 12. Place an "X" on the blank beside each true statement about the importance of the third wire.

_____56. It is installed for personal protection

_____57. It provides a straight path for current in case of a short

_____58. It can save your life

Part 13. Place an "X" on the blank beside each safe practice for working around live circuits.

_____59. Use a neon test light or voltmeter to identify live circuits

_____60. Stand on wet concrete only in emergencies

_____61. Use only one hand if possible

_____62. Never keep tools lying around live conductors

_____63. Wear suitable insulated hand covering

Part 14. Match the ampere figures below to the effects on the human body by placing the correct letter on the blank.

A.	over .100	E.	.0005 to .002
B.	.0005 or less	AB.	.005 to .025
C.	.050 to .200	AC.	.025 or more
D.	.002 to .010		

_____64. No sensation

_____65. Threshold of perception

_____66. Muscular contraction (mild to strong)

_____67. Painful shock, inability to let go

_____68. Violent muscular contraction

_____69. Ventricular fibrillation (convulsive movement of the heart--FATAL)

_____70. Paralysis of breathing (Apply artificial respiration IMMEDIATELY)

Part 15. Discuss ground fault interrupters.

71.

Part 16. Discuss rescue procedures in case of electrical accidents.

72.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

ANSWERS TO UNIT I, LESSON 1 TEST

Part 1.

1. D
2. E
3. B
4. AB
5. A
6. C
7. AC

Part 2.

8. A
9. C
10. B
11. D

Part 3.

12. X
13.
14. X

Part 4.

15.
16. X
17. X
18. X
19. X
20.

Part 5.

21.
22. X
23.
24. X

Part 6.

25. X
26.
27. X
28.
29.
30.

Part 7.

31. X
32.
33. X
34.

Part 8.

35. X
36.
37. X
38.
39. X
40. X

Part 9.

41.
42.
43.
44.
45.
46.

Part 10.

47.
48.
49. X
50. X
51. X
52. X

Part 11.

53. X
54. X
55. X

Part 12.

56. X
57.
58. X

Part 13.

59. X
60.
61. X
62. X
63. X

Part 14.

64. B
65. E
66. D
67. AB
68. AE
69. C
70. A

Part 15.

71. Discussion should include:
    a. Personal safety device
    b. Required on 15 and 20 ampere receptacle used for temporary supply on construction sites
    c. Stops current before severe personal injury occurs

72. Discussion should include:
    a. Locate live wire and disconnect if possible
    b. Decide whether it would be easier to move the person or the conductor
    c. With paper or cloth in hand quickly pull victim free of the conductor

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 2: TROUBLESHOOTING AND REPLACING OUTLETS, SWITCHES, FUSES, BREAKERS, AND FIXTURES

LESSON OBJECTIVE

After the completion of this lesson, the student will be able to TROUBLESHOOT A DEFECTIVE RECEPTACLE, SWITCH, FUSE/BREAKER, AND IDENTIFY A HOT WIRE. Mastery will be evidenced by satisfactorily completing job sheets and by scoring ____________ percent on the lesson test.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Define troubleshooting.
2. List nine troubleshooting procedures.
3. Discuss each troubleshooting procedure.
4. Demonstrate the ability to locate the hot wire in a switch, receptacle or light fixture.
5. Demonstrate the ability to troubleshoot a receptacle.
6. Demonstrate the ability to troubleshoot a switch.
7. Demonstrate the ability to check for a defective fuse/breaker.

Completion of the requirements of this lesson fulfills competency D-2 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 2: TROUBLESHOOTING AND REPLACING OUTLETS, SWITCHES, FUSES, BREAKERS, AND FIXTURES

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Job sheets
  1. Checking for the hot wire
  2. Checking/replacing a defective switch
  3. Checking/replacing a defective receptacle
  4. Checking/replacing a defective circuit breaker
  5. Checking/replacing a defective fuse

D. Lesson test

E. Answers to lesson test

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 2: TROUBLESHOOTING AND REPLACING OUTLETS, SWITCHES, FUSES, BREAKERS, AND FIXTURES

INFORMATION OUTLINE

I. Terms and definitions

  A. Troubleshooting--the process of locating malfunctions in machines and electrical equipment

II. Basic troubleshooting procedures

  A. Turn off power

  B. Understand the system
    1. Know the system's physical parts
    2. Know the system's voltage and other information
    3. Try to trace out circuits mentally and physically if possible

  C. Ask the owner or a person familiar with the system about the problem
    1. Ask about symptoms
    2. Ask about maintenance
    3. Ask if problem has happened before

  D. Inspect the system
    1. Smell for unusual odors
    2. Look for frayed cords
    3. Look for loose plugs and loose receptacles
    4. Feel for heat
    5. Look for burn marks, discolorations
    6. Watch for improperly installed or connected appliances

  E. Operate system, if safely possible
    1. Check voltages
    2. Turn off switches
    3. Unplug appliances
    4. Inspect the system as listed

  F. List possible problem causes

  G. Reach a conclusion mentally

  H. Test conclusion physically and, above all, safely

I. Repair system, if possible

J. Replace, if necessary

CHECKING FOR THE HOT WIRE

Equipment:

Volt meter
Receptacle installation
Screwdriver
Safety glasses

Procedure:

Evaluation
3 2 1 N

(CAUTION: Instructor MUST be present.)

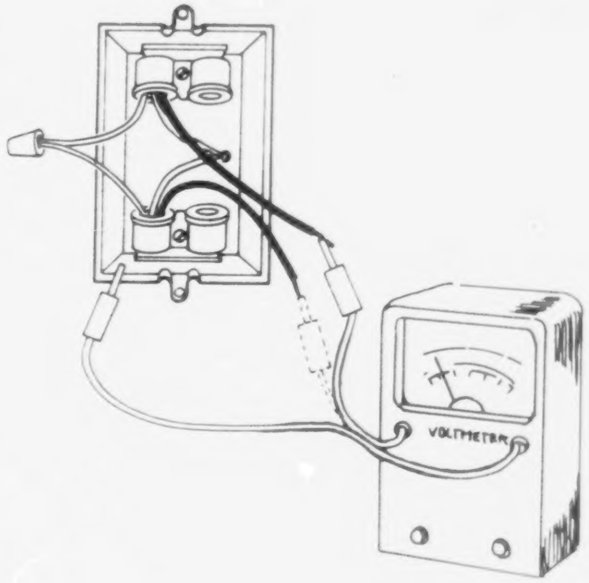
1. Turn OFF power to the wires to be tested. ___ ___ ___ ___

2. Remove the free plate of the receptacle, switch, or light fixture in order to gain access to the wire to be tested. ___ ___ ___ ___

3. Remove switch, receptacle, or light fixture. ___ ___ ___ ___

Checking for the hot wire in a grounded system

4. Separate or disconnect the hot wires as noted in the illustration. ___ ___ ___ ___

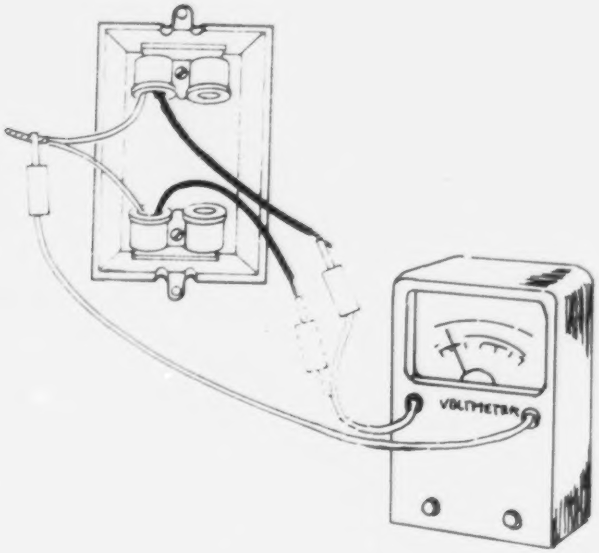


5. Turn on the voltage. ___ ___ ___ ___

6. Carefully place the volt meter leads as shown. (The wire that causes the volt meter to respond is not the lead.) — — — —

Checking for the hot wire in a non-grounded system

7. Separate or disconnect the hot wires as noted in the illustration. — — — —



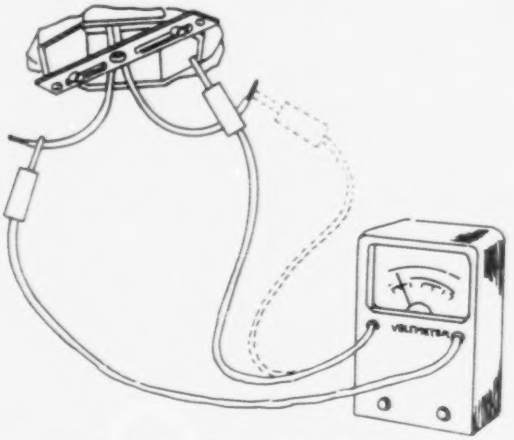
8. Remove the solderless connector from the neutral wire and use this instead of the metal box. — — — —

9. Turn on voltage.

10. Carefully place the volt meter leads as shown. (As before, the wire that causes the volt meter to light is the hot wire.) — — — —

Checking for the hot wire in a light fixture

11. Follow the same procedures as in the previous examples. Note the illustration. — — — —



12. Have instructor check your work. — — — —

13. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

Average of above evaluations* — — — —

*This average is the student's partial evaluation for competency D-2 of Building Maintenance.

JS 2

CHECKING/REPLACING A DEFECTIVE SWITCH

Equipment:

Volt meter
Electrical switch installation
Screwdriver
Safety glasses

Procedure:

Evaluation
3 2 1 N

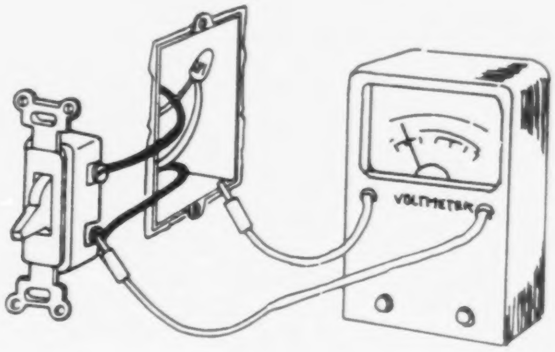
(CAUTION: Instructor MUST be present.)

1. Carefully remove switch plate cover. ___ ___ ___ ___

2. Before starting this test procedure, be sure the power to the suspected switch has been turned OFF. Unscrew the switch from the junction box. Pull the switch away from the metal box. When the switch is in a safe position, power may be restored and the test procedure may be started. ___ ___ ___ ___

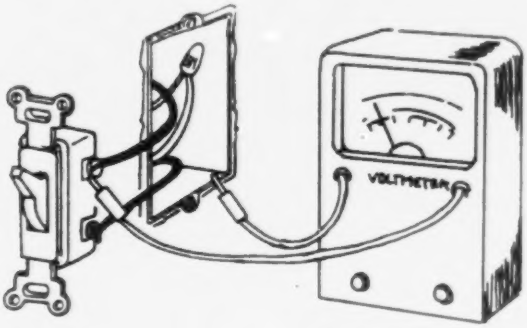
3. Position the volt meter as shown in the illustration with one lead on the bottom terminal and the other lead to the metal box (if system is grounded). ___ ___ ___ ___

(Note: On older homes and those that have plastic boxes that do not have a ground, it is necessary to remove the wire nut from the neutral wire and use the neutral as the other test point. This test determines if voltage is reaching the switch.)



4. Identify the hot wire (see Job Sheet 1). ___ ___ ___

5. With the switch in the on position, voltage should be present at both terminals of the switch if switch is working correctly. This test determines if voltage is going through switch. ___ ___ ___ ___



6. If voltage is not present at both terminals with switch in the on position, the switch is defective. ___ ___ ___ ___

7. Replace switch. ___ ___ ___ ___

8. If voltage is not present at either terminal, the problem is with the circuit breakers (fuses) or in the electrical circuit leading to the troubled switch. ___ ___ ___ ___

9. Have instructor check your work. ___ ___ ___ ___

10. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

***This average is the student's partial evaluation for competency D-2 of Building Maintenance.**

JS 3

CHECKING/REPLACING A DEFECTIVE RECEPTACLE

Equipment:

Volt meter
Receptacle
Screwdriver
Safety glasses

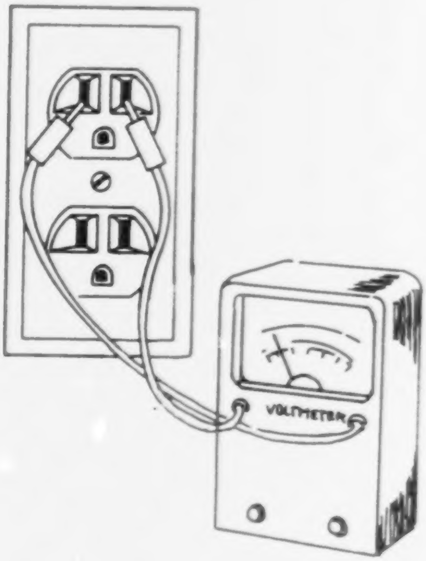
Procedure:

Evaluation
3 2 1 N

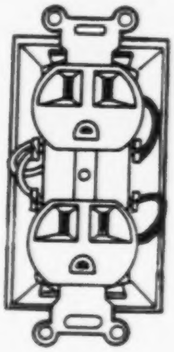
(CAUTION: Instructor MUST be present.)

1. Press each lead of the volt meter into the receptacle slots. __ __ __ __

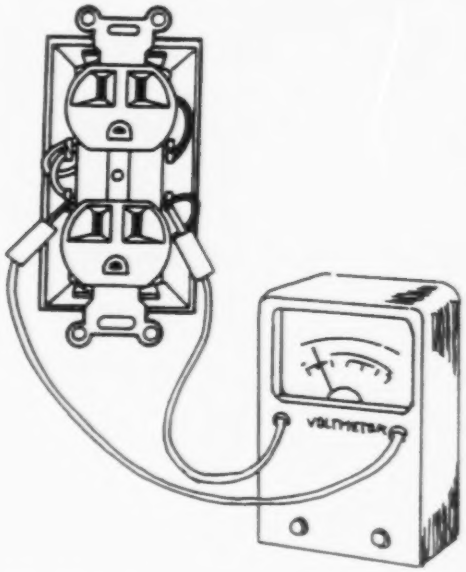
(Note: If voltage is present, the meter will respond indicating voltage level.)



2. If there is no voltage, remove the receptacle cover. — — — —



3. Carefully check the voltage at the receptacle terminals. — — — —



4. If voltage is present at the terminals, but not at the receptacle, replace receptacle. — — — —

5. If there is no voltage at the terminal, check breakers and/or fuses. — — — —

6. Have instructor check your work. — — — —

7. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-2 of Building Maintenance.

JS 4

CHECKING/REPLACING A DEFECTIVE CIRCUIT BREAKER

Equipment:

Volt meter
Service installation with breakers
Screwdriver
Safety glasses

Procedure:

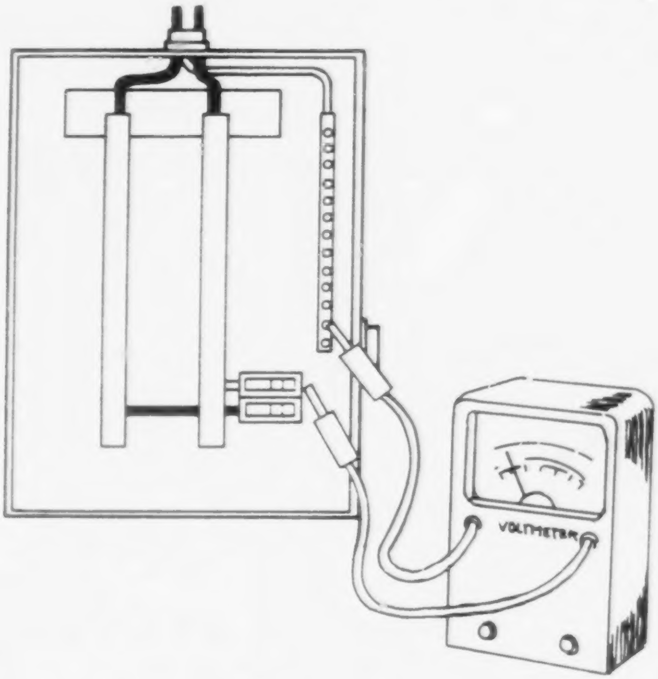
Evaluation
3 2 1 N

(CAUTION: Instructor MUST be present.)

1. Remove cover of the breaker box. ___ ___ ___ ___

2. Place one lead of volt meter on the neutral bar. ___ ___ ___ ___

3. Place the other lead on the screw terminal of the circuit breaker. See illustration. ___ ___ ___ ___



4. If breaker is good, the meter will respond when the breaker is in the ON position and will not when the breaker is in the TRIPPED position. ___ ___ ___ ___

5. If the volt meter responds in both positions, the breaker is shorted and should be replaced. ___ ___ ___ ___

6. If the volt meter does not respond in either position, the breaker is open and should be replaced. ___ ___ ___ ___

7. Have instructor check your work. ___ ___ ___ ___

8. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

***This average is the student's partial evaluation for competency D-2 of Building Maintenance.**

CHECKING/REPLACING A DEFECTIVE FUSE

Equipment:

Volt meter
Live fuse box and fuses
Screwdriver
Safety glasses

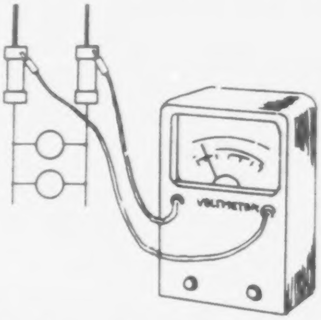
Procedure:

Evaluation
3 2 1 N

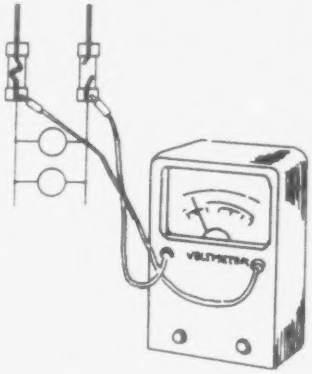
(CAUTION: Instructor MUST be present.)

1. Remove cover of fuse box. ___ ___ ___ ___

2. Place tester leads to top of fuses to see if voltage is present. ___ ___ ___ ___

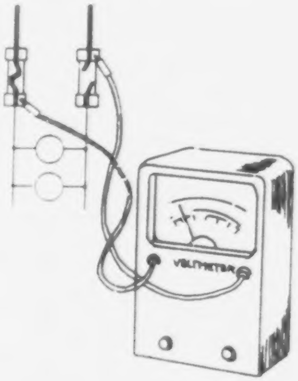


3. Next, place leads on bottom of fuses to see if voltage is passing through fuse. ___ ___ ___ ___



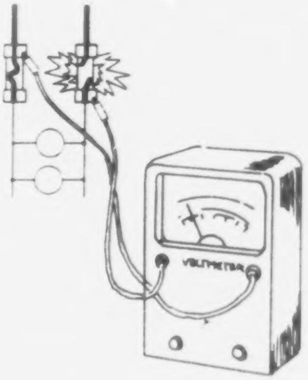
4. Failure of the meter to respond indicates one or both fuses is defective.

5. Check the left fuse to see if voltage is present.



6. If meter responds, fuse is good. Failure to respond shows fuse is defective. SHUT OFF power and replace fuse.

7. Check the right fuse to see if voltage is present.



8. If meter responds, fuse is good. Failure to respond shows fuse is defective. SHUT OFF power and replace fuse.

9. Have instructor check your work.

Average of above evaluations*

*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 2: TROUBLESHOOTING AND REPLACING OUTLETS, SWITCHES, FUSES, BREAKERS, AND FIXTURES

LESSON TEST

Part 1. Place an "X" on the blank beside each correct troubleshooting procedure for locating malfunctions in machines and electrical equipment.

_____ 1. Turn off power

_____ 2. Understand the system, its circuits, voltage, etc.

_____ 3. Don't rely on reports of the owner or regular maintenance person

_____ 4. Inspect the system looking for unusual odors, frayed cords, loose plugs, receptacles, burned marks, etc.

_____ 5. Operate the system no matter what condition it is in--that is the only way you can tell what is wrong

_____ 6. List possible problem causes

_____ 7. Reach a conclusion mentally

_____ 8. Make repairs based on that conclusion

_____ 9. Test your mental conclusions physically and, above all, safely

_____10. Repair system, if possible, based on those tests

_____11. Replace system if necessary

Part 2.

12. Define troubleshooting.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

ANSWERS TO UNIT I, LESSON 2 TEST

Part 1.

1. X
2. X
3.
4. X
5.
6. X
7. X
8.
9. X
10. X
11. X

Part 2.

12. The process of locating malfunctions in machines and electrical equipment

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 3: CUT, REAM, BEND AND CONNECT CONDUIT

LESSON OBJECTIVE

After completion of this lesson, the student will be able to IDENTIFY TOOLS NEEDED FOR CUTTING, REAMING, BENDING AND CONNECTING CONDUIT. The student will also be able to USE THESE TOOLS TO PREPARE AND CONNECT CONDUIT. Mastery will be evidenced by completing job sheets and by scoring ____________ percent on the lesson test.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Identify cutting, reaming and bending tools necessary for connecting conduit.
2. Identify the types of conduit.
3. Set up and use a hacksaw.
4. Cut rigid conduit with a pipe cutter.
5. Ream rigid conduit.
6. Bend a 90° stub with 1/2" EMT.
7. Connect conduit.

Completion of the requirements of this lesson fulfills competency D-3 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 3: CUT, REAM, BEND AND CONNECT CONDUIT

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
    1. Cutting, bending and reaming tool

D. Job sheets
    1. Set up and use a hacksaw
    2. Cut rigid conduit with a pipe cutter
    3. Ream rigid conduit
    4. Bend a 90° stub with 1/2" EMT
    5. Connect conduit

E. Lesson test

F. Answers to lesson test

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 3: CUT, REAM, BEND AND CONNECT CONDUIT

INFORMATION OUTLINE

I. Terms and definitions

- A. Conduit--a tube or duct for enclosing electric wires or cable
- B. Ream--to enlarge a hole with a reamer

II. Tools needed for cutting, reaming and bending conduit (TM 1)

- A. Hickey (tube) bender
- B. Pipe reamer and files
- C. Pipe cutter
- D. Hacksaw

III. Tools needed for connecting conduit

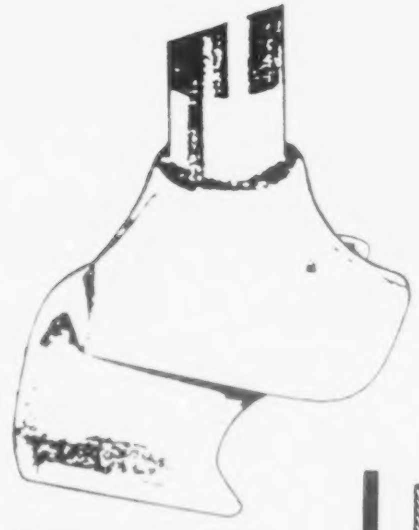
- A. Adjustable wrenches
- B. Screw drivers

IV. Types of conduit

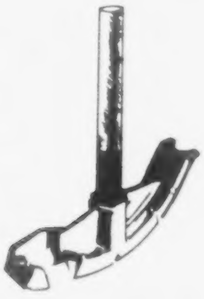
- A. Rigid conduit
    1. Supplied in a full complement of diameters
    2. Cut and threaded with the same tools used for plumbing
    3. Thin wall conduit is not threaded, but is connected by using mechanical connections known as compression type or set screw type
- B. Flexible conduit
    1. Supplied in a full complement of diameters
    2. Cut with a hacksaw
    3. All connectors are of the mechanical type

TM 1

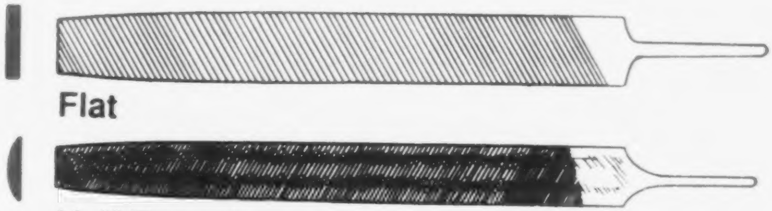
Cutting, Bending and Reaming Tools



Hickey Bender



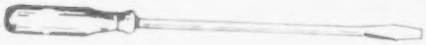
EMT Bender

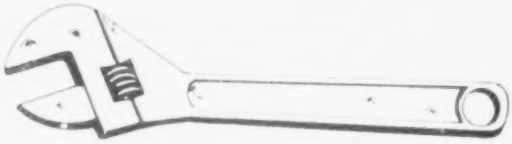


Flat

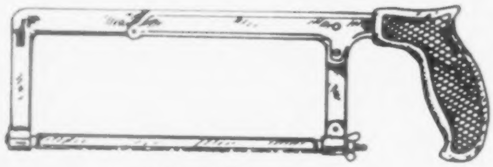
Half Round

Files

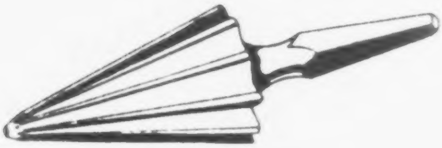




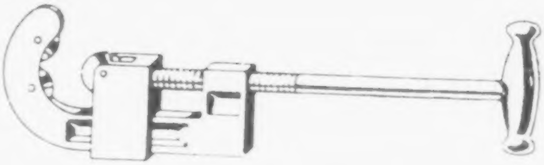
Adjustable Wrench



Hacksaw



Pipe Reamer



Pipe Cutter

SET UP AND USE A HACKSAW

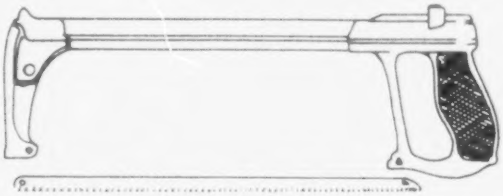
Equipment:

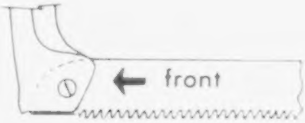
Hacksaw
Hacksaw blade
(Note: For cutting pipe or conduit, a 24- or 32-teeth-per-inch blade is recommended.)
Pipe or conduit
Safety glasses

Procedure: Evaluation 3 2 1 N

1. Put on safety glasses and gather tools and equipment. ___ ___ ___ ___
2. Insert blade in frame. ___ ___ ___ ___

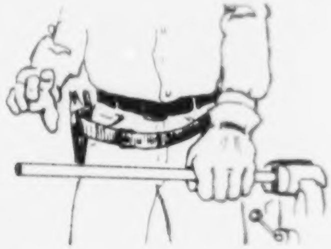
   (Note: Be sure teeth angles are pointed toward the front of the saw.)





3. Secure pipe or conduit for cutting. — — — —

(Note: Short pieces of pipe are easier to cut in a vise.)



4. Rest the blade on the pipe or conduit at the point to be cut. — — — —

5. Push forward gently until cut is started. — — — —

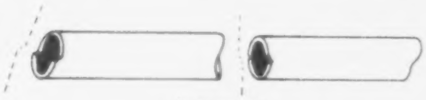
(Note: Do not exert extra pressure on the saw.)

6. Make reciprocal strokes until cut is finished. — — — —

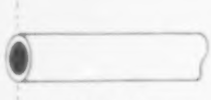
(Note: Excessive speed while cutting can ruin blades. You should not use more than 30 full strokes per minute.)

7. Have instructor check your cut. — — — —

(Note: Your cut should be straight and relatively smooth.)



incorrect



correct

8. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

Average of above evaluations* — — — —
*This average is the student's partial evaluation for competency D-3 of Building Maintenance.

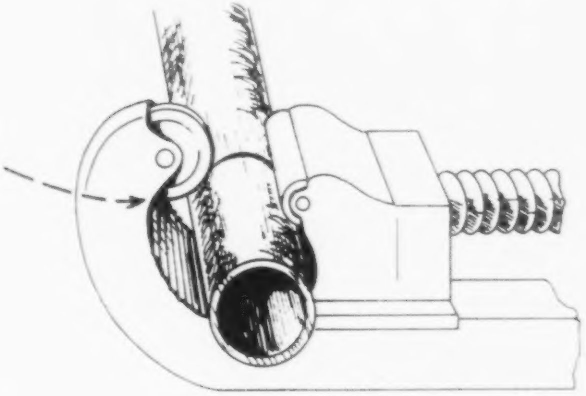
CUT RIGID CONDUIT WITH A PIPE CUTTER

Equipment:

- Pipe vise
- Pipe cutter
- Rigid conduit
- Cutting oil
- Safety glasses
- Shop towel
- Pencil

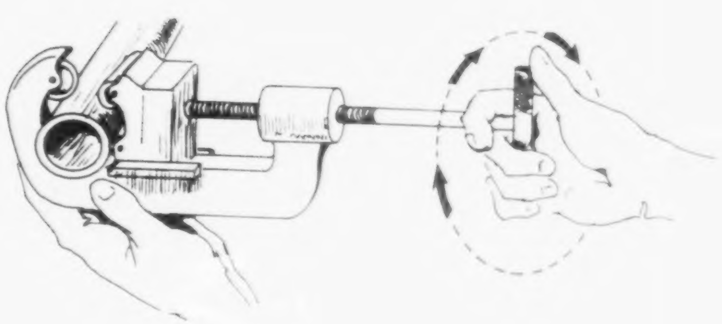
Procedure:

	Evaluation			
	3	2	1	N
1. Put on safety glasses and gather tools and equipment.	___	___	___	___
2. Secure conduit in vise.	___	___	___	___
3. Mark place for cut with pencil.	___	___	___	___
4. Open pipe cutter until it will fit over conduit.	___	___	___	___
5. Locate cutter wheel on the pencil mark.	___	___	___	___

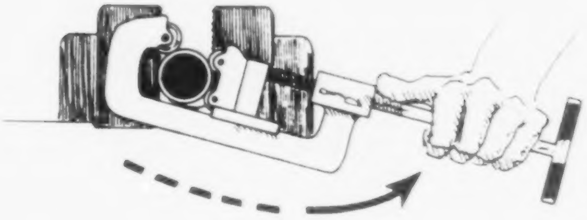


6. Snug cutter up to conduit by rotating screw handle. __ __ __ __

(Note: Don't overtighten because this can break the cutter wheel.)



7. Rotate cutter counterclockwise to start groove. __ __ __ __



8. Tighten cutter hand 1/4 of a turn for each full revolution around the pipe. __ __ __ __

(Note: Overtightening can cause cutters to break.)

9. Add a small amount of cutting oil to the groove. __ __ __ __

(Note: When cutting short pieces of conduit, be careful not to cut your arm while rotating the cutter around the pipe.)

10. Continue process until conduit is cut. ___ ___ ___ ___

(Note: Be prepared to catch free piece of conduit.)

11. Clean conduit and cutter with shop towel. ___ ___ ___ ___

12. Have instructor inspect work. ___ ___ ___ ___

13. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-3 of Building Maintenance.

JS 3

REAM RIGID CONDUIT

Equipment:

Pipe vise
Piece of rigid conduit
Files
Safety glasses
Reamer
(Note: You will need a rachet hand or brace depending on which type reamer you are using.)

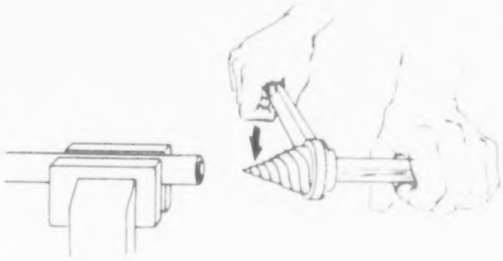
Procedure:

Evaluation
3 2 1 N

(Note: Be safety conscious around cut pieces of rigid conduit. Sharp ridges or spurs can cause deep cuts.)

1. Place conduit in vise. ___ ___ ___ ___

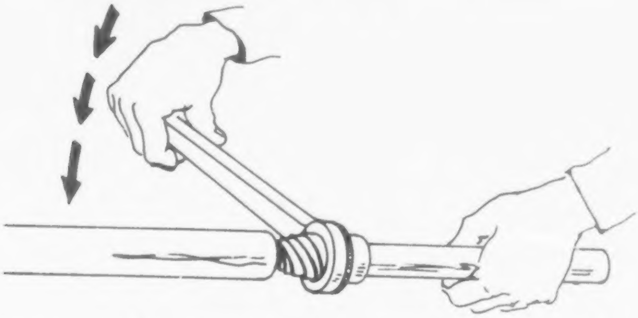
2. Insert reamer tip in conduit. ___ ___ ___ ___



3. Apply light forward pressure to push reamer into conduit. ___ ___ ___ ___

4. Start rotating reamer.

(Note: Reamer should bite instantly if proper pressure is applied. Reamer can be damaged if rotated in the wrong direction.)

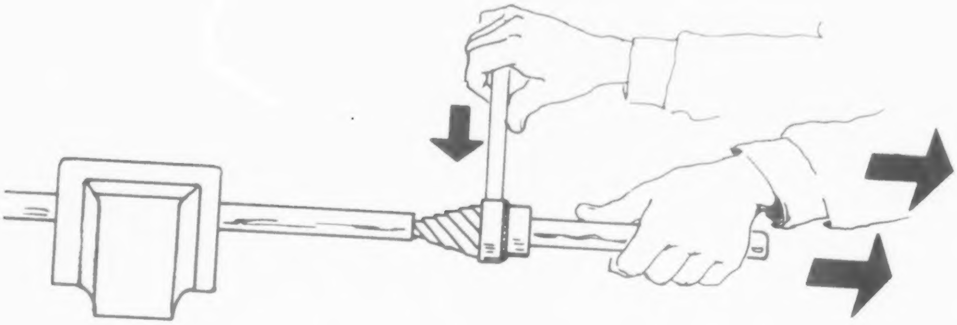


5. Rotate reamer until burrs are removed.

(Note: This is a developed skill. The reamer can be pulled out and your progress inspected.)

6. Pull reamer back while continuing to rotate.

(Note: This prevents the reamer from leaving a burr.)



7. File end of tubing square and remove the burr from the outside.

8. Have the instructor evaluate your work.

9. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-3 of Building Maintenance.

JS 4

BEND A 90° STUB WITH 1/2" EMT

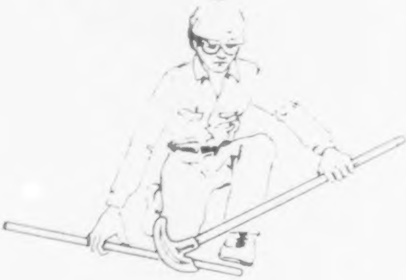
(Note: Because of the difference in bender shoe markings, the height of this bend and its determination will be left to the instructor.)

Equipment:

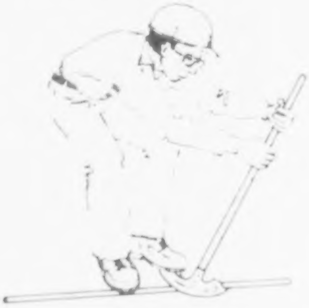
1/2" EMT bender
1/2" EMT (length optional)
Safety glasses

Procedure:

	Evaluation 3 2 1 N
1. Put on safety glasses and gather tools and equipment.	___ ___ ___ ___
2. Place conduit in the bender jaw.	___ ___ ___ ___

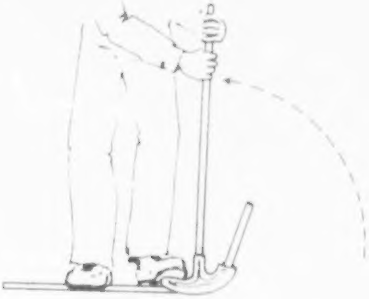


3. Apply light pressure on handle to hold conduit in place.	___ ___ ___ ___
4. Place one foot on bender kick pad.	___ ___ ___ ___
5. Place other foot on conduit.	___ ___ ___ ___

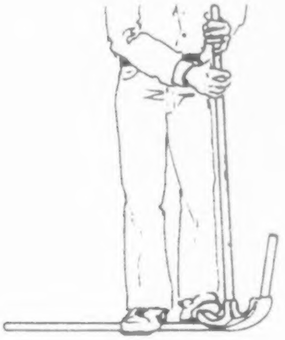


6. Apply heavy pressure on bender kick pad while pulling handle to a straight-up position. — — — —

(Note: If pressure is not applied solidly to kick pad, conduit can wrinkle or collapse.)

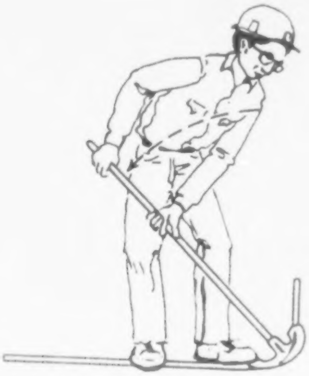


7. Reposition feet for comfort. — — — —



8. Reapply kick pad and bender handle pressure until bend is completed. ___ ___ ___ ___

Note: A square can be used to evaluate your accuracy until you develop your skills.)



9. Have instructor evaluate your work. ___ ___ ___ ___

10. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-3 of Building Maintenance.

CONNECT CONDUIT

Equipment:

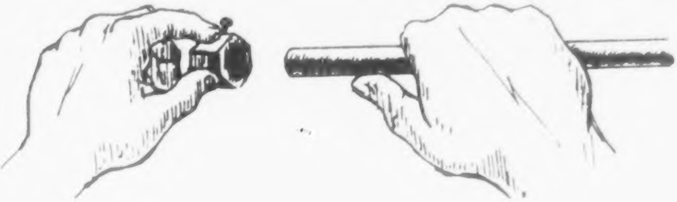
Prepared conduit
Connectors and boxes
Adjustable wrenches
Screwdrivers
Safety glasses

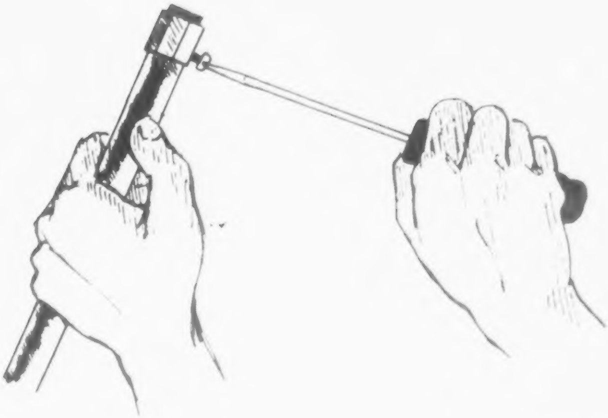
Procedure:

Evaluation
3 2 1 N

1. Select prepared lengths of conduit, proper connectors and boxes. ___ ___ ___ ___

2. Place connector over the end of the conduit and tighten firmly in place with the proper tool. ___ ___ ___ ___





3. Remove locking nut from connector and place connector into the hole in the box. ____ ____ ____ ____

4. Replace lock nut inside the box and tighten. ____ ____ ____ ____

5. Have instructor inspect your work. ____ ____ ____ ____

6. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ____ ____ ____ ____

Average of above evaluations* ____ ____ ____ ____

---

*This average is the student's partial evaluation for competency D-3 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

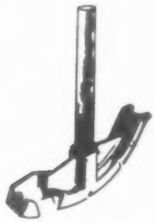
LESSON 3: CUT, REAM, BEND AND CONNECT CONDUIT

LESSON TEST

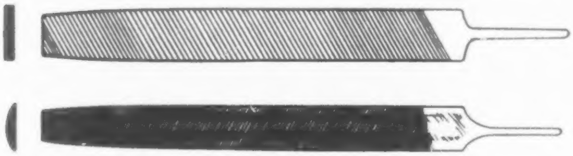
Part 1. Match the names of tools for preparing and connecting conduit with their pictures.

A. Tube cutter
B. Bending Hickey
C. Reamer
D. Screwdriver
E. Adjustable wrenches
AB. Files

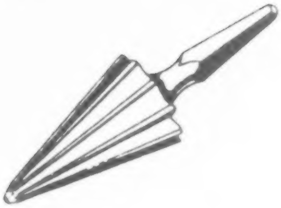
______ 1.



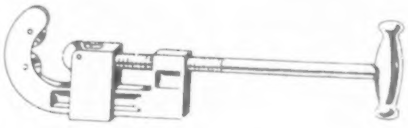
______ 2.



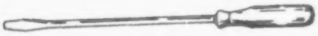
______ 3.



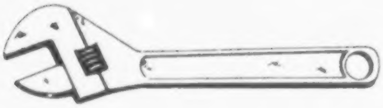
______ 4.



_____ 5.



_____ 6.



Part 2. Match the tools listed below with their correct uses.

A. Adjustable wrench
B. Files
C. Tube cutter
D. Hacksaw
E. Screw driver
AB. Reamer

_____ 7. Cut rigid conduit

_____ 8. Cut flexible conduit

_____ 9. Remove inside burr

_____10. Remove outside burr

_____11. Attach set screw connectors

_____12. Attach compression connectors

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

ANSWERS TO UNIT I, LESSON 3 TEST

Part 1.

1. B
2. AB
3. C
4. A
5. D
6. E

Part 2.

7. D & C
8. D
9. AB
10. B
11. E
12. A

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 4: WIRING CIRCUITS TO CODE 115-VOLT (15 AND 20 AMP) AND 240-VOLT

LESSON OBJECTIVE

After completion of this lesson, the student will be able to DRAW A WIRING PLAN, IDENTIFY ELECTRICAL SYMBOLS AND SELECT CABLE. The student will also be able to PERFORM WIRING JOBS ACCORDING TO CODE AND CORRECT PROCEDURES. Mastery will be evidenced by satisfactory completion of assignment sheets and job sheets and by scoring ____________ percent on the lesson test.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Match terms associated with planning a wiring layout to the correct definition.
2. Identify electrical symbols used in a wiring plan.
3. Point out the sizes of electrical cables.
4. Select the correct planning procedures for outlets and switches.
5. Identify three types of branch circuits.
6. Figure the number of branch circuits required for various wiring situations.
7. Match the terms associated with electrical wiring procedures to the correct definitions.
8. Identify the correct splices and connections to use for each wiring procedure.
9. Identify the signs of and reasons for wiring failure.
10. Mount electrical boxes.
11. Install NM cable in electrical boxes.
12. Install duplex receptacles (15 Amp).
13. Install single-pole switches.

14. Install three-way switches.

15. Install dimmer switch.

16. Install appliance receptacles (20 Amp).

17. Install 240-volt appliance circuit.

Completion of the requirements of this lesson fulfills competency D-4 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 4: WIRING CIRCUITS TO CODE
115-VOLT (15 AND 20 AMP) AND 240-VOLT

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
    1. Branch circuit
    2. Electrical symbols
    3. Planning outlets and switches
    4. Never locate outlets near tub or shower
    5. Entrance panel
    6. Duplex receptacle
    7. Single-pole switch
    8. Dimmer switch

D. Assignment sheets
    1. Figure general purpose branch circuits needed
    2. Draw a wiring plan

E. Answers to assignment sheets

F. Job sheets
    1. Mount electrical boxes
    2. Install non-metallic (NM) cable in electrical boxes
    3. Install duplex receptacle
    4. Install single-pole switch
    5. Install three-way switch
    6. Install dimmer switch
    7. Install duplex appliance receptacle
    8. Install 240V appliance circuit

G. Lesson test

H. Answers to lesson test

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

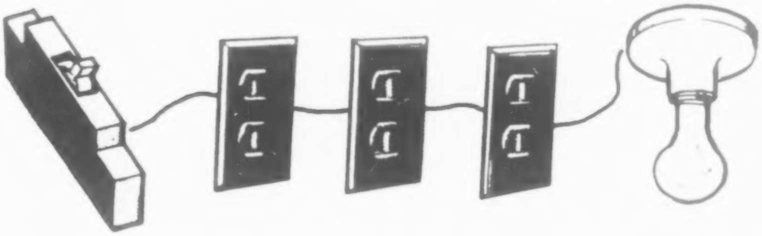
UNIT I: ELECTRICAL PROCEDURES

LESSON 4: WIRING CIRCUITS TO CODE
115 VOLT (15 AND 20 AMP) AND 240-VOLT)

INFORMATION OUTLINE

I. Terms and definitions

A. Branch circuit--all the outlets and receptacles connected on one breaker (TM 1)



B. Breaker--a safety switch that connects the branch circuit to the power source

C. Special purposes outlet--any outlet for appliances that used 240-volts, or motors larger than 1/3 horsepower

D. Wiring plan--a drawing of the house floor plan showing switch wiring and outlets

E. Wire--a single conductor

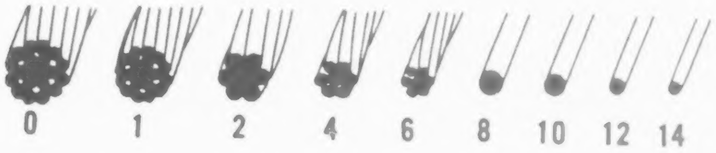
F. Electrical cable--two or more wires put together inside an insulating cover

G. Cord--several small wires put together in an insulating cover, usually very flexible

H. Wire size--measure of wire diameter and called the "gauge" of wire

I. Wire gauge number--the number that determines the size of the wire for 4/0 to 14

(Note: The smaller the number, the larger the wire diameter)



J. Ground wire--usually bare or green wire that connects circuit to earth for safety

K. Hot wire--usually black, but can be any color except green and always has voltage applied to it

(CAUTION: Assume all wires to be HOT when checking a circuit)

L. Neutral wire--usually white, and serves as a return for current

M. Junction box--a covered outlet box used to enclose splices within a circuit

N. Outlet box--a box used to bring the wires to a switch, receptacle, or light

O. Terminal--a connection between the wires and electrical devices usually fastened with a screw or clip

P. Duplex receptacle--a contact device that is installed at an outlet for connection of two single plugs

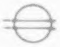
Q. Single-pole switch--a switch that controls a circuit in one place

R. Three-way switch--a switch to control a circuit in two places

S. NM--non-metallic cable

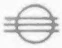
II. Symbols used in wiring plans (TM 2)

A. Duplex receptacle outlet

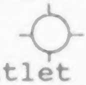


B. Special purpose outlet

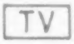
C. 240-volt outlet



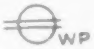
D. Ceiling light outlet



E. TV outlet



F. Weatherproof duplex outlet



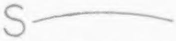
G. Single pole switch

S

H. Three-way switch

S_3

I. Switch wiring



III. Selecting wire size

A. Electrical wire varies from No. 40 to No. 4/0 or 0000

(Note: The larger the gauge number, the smaller the wire diameter)

B. Reading wire sizes
1. The first number is the gauge (size) of the wire
2. The second number shows how many conductors are in the wire
   (Example: 12/2 = 12 gauge, 3 conductors)

C. Amp rating for wires

Wire Size (Gauge)	Amp Rating
14	14
12	20
10	30
8	40
6	50
4	70
2	95
1	110
1/0 or 0	215
2/0 or 00	145
4/0 or 0000	195

IV. Planning outlets and switches (TM 3, TM 4, TM 5, TM 6, TM 7, TM 8)

A. Living room, bedroom, den or dining room
   1. One or more ceiling lights controlled by a wall switch
   2. Duplex outlets on walls, to be no more than 6 feet apart

B. Kitchen
   1. One of more ceiling lights controlled by wall switch
   2. One light over sink, with wall switch
   3. Special purpose outlet for dishwasher, disposal, and refrigerator
   4. Special purpose outlet for electric range
   5. Duplex outlets spaced every 4 feet in work area and 12 feet apart in remainder of kitchen

C. Laundry and utility room
   1. One or more ceiling lights controlled by wall switch
   2. Grounded duplex outlets
   3. Special purpose outlets for dryer, water heater, electric furnace, or air conditioner

D. Bathroom
   1. One or more lighting outlets located near mirror, with wall switch
   2. Duplex receptacles near mirror

   (CAUTION: Never locate duplex receptacles or switches where they can be reached from tub or shower)

E. Halls
   1. One ceiling light controlled by three-way wall switch
   2. One duplex outlet every 12 feet

F. Stairways and closets
   1. One light for each landing, controlled by three-way switch
   2. One ceiling light for each closet

G. Exterior entrances
   1. At least one light for each entrance, controlled by inside switch
   2. One duplex weatherproof receptacle at front and back entrances

H. Garage
  1. **AT LEAST one ceiling light, controlled by three-way switch**
  2. **AT LEAST two duplex outlets on rear and side walls**
  3. **One duplex outlet in ceiling for door closer**

V. Types of branch circuits

A. General purpose--20 amp

B. Small appliance--20 amp

C. Special purpose individual outlet--50 amp

VI. Figure branch circuits needed

A. General purpose 20 amp branch circuits
  1. One branch circuit for each 500 square feet of floor space
  2. Nine outlets per general purpose circuit
  3. Add total number of outlets, divide by 9, counting any fraction as a whole

(Example: A house has 30 general purpose outlets. To find the number of general purpose branch circuits needed:
30 - 9 = 3.3 or 4 circuits needed)

(Note: Do not count small outlets on small appliance circuits)

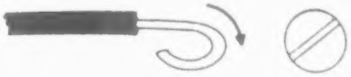
B. Small appliance branch circuits
  1. Three circuits per house
  2. Three outlets for each circuit
  3. Used in kitchen, laundry room, and dining room

C. Special purpose individual circuits
  1. One circuit for each outlet
  2. 240-volt outlets
  3. 1/3 horsepower or larger

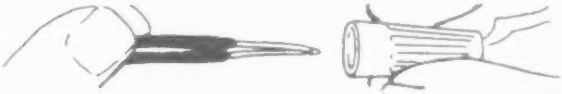
VII. Splices and connections

A. Insulation removal

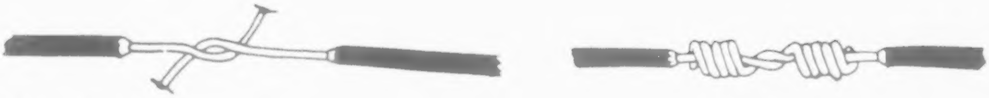
B. Terminal loop



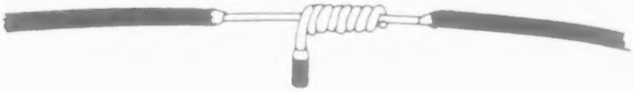
C. Solderless connection using wire nut



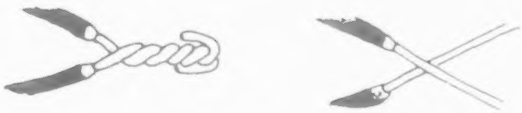
D. Splicing two wires



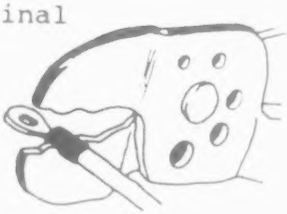
E. Tap splice



F. Pigtail splice



G. Solderless terminal



VIII. Signs of poor wiring

A. Blown fuse

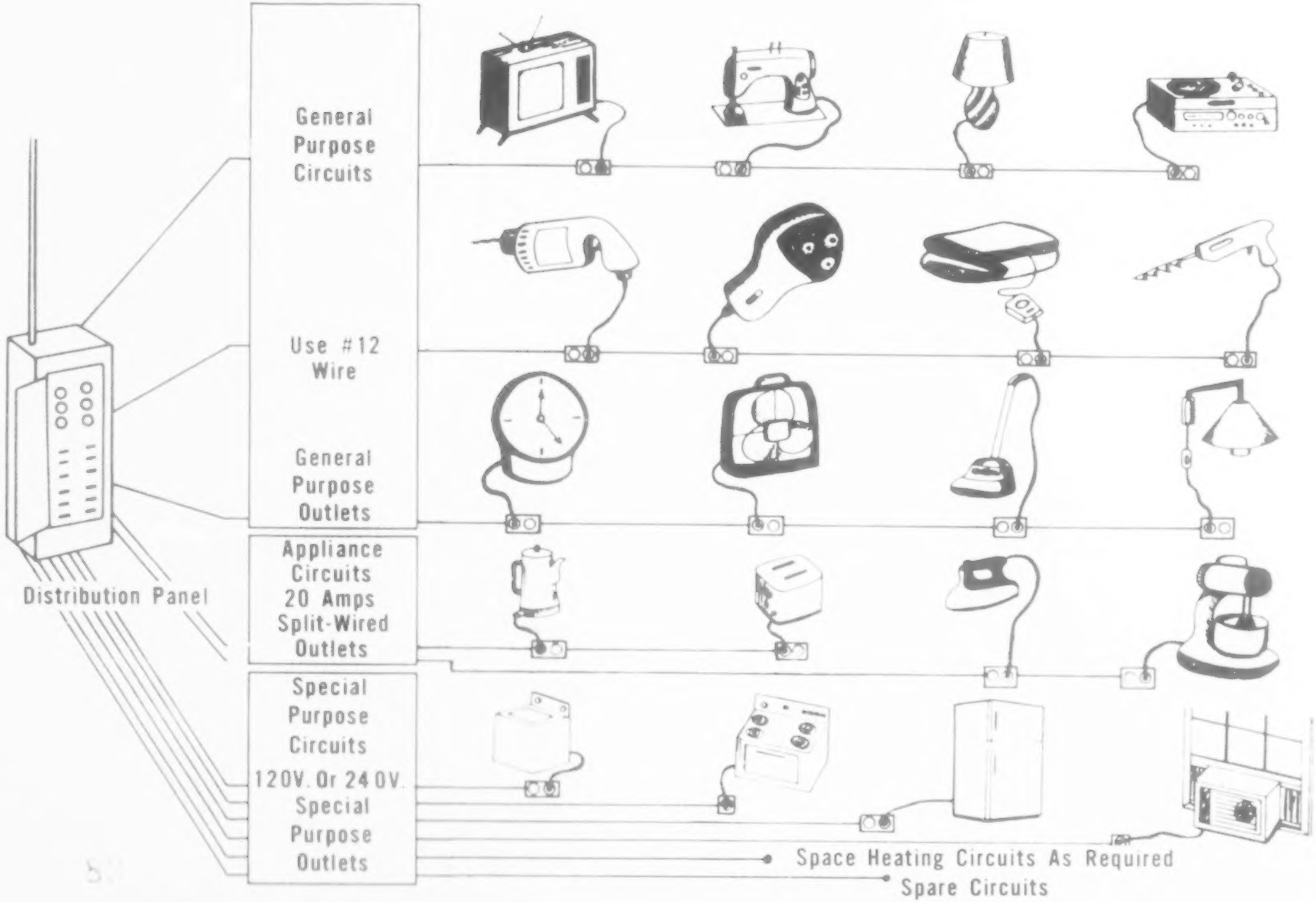
B. Tripped circuit breaker

C. Flickering or dim lights

D. Poorly-operating appliances

E. Heat--hot wires, cords or outlets
   1. Overloaded circuits
   2. Breaker or fuse too small
   3. Shorted circuit
   4. Loose or broken wires
   5. Faulty equipment

Branch Circuit



General Purpose Circuits

Use #12 Wire

General Purpose Outlets

Appliance Circuits 20 Amps Split-Wired Outlets

Special Purpose Circuits

120V. Or 240V.

Special Purpose Outlets

Distribution Panel

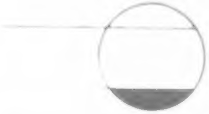
Space Heating Circuits As Required

Spare Circuits

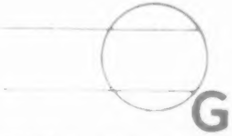
EP 105

TM 1

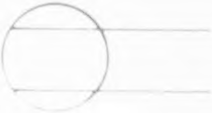
Electrical Symbols



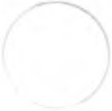
Duplex Convenience Outlet-Split Wired



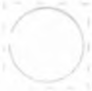
Duplex Grounding Outlet



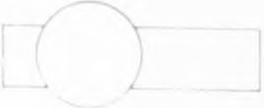
Duplex Convenience Outlet



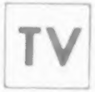
Lighting Outlet



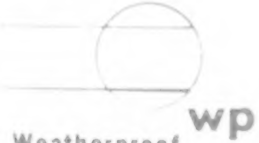
Ceiling Lighting Outlet



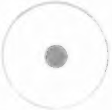
Fluorescent Lighting



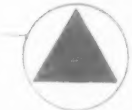
Television Outlet



Weatherproof Duplex Outlet



Floor Outlet



Special-Purpose Outlet

S

Single-Pole Switch

S_3

Three-Way Switch

S_4

Four-Way Switch

S_p

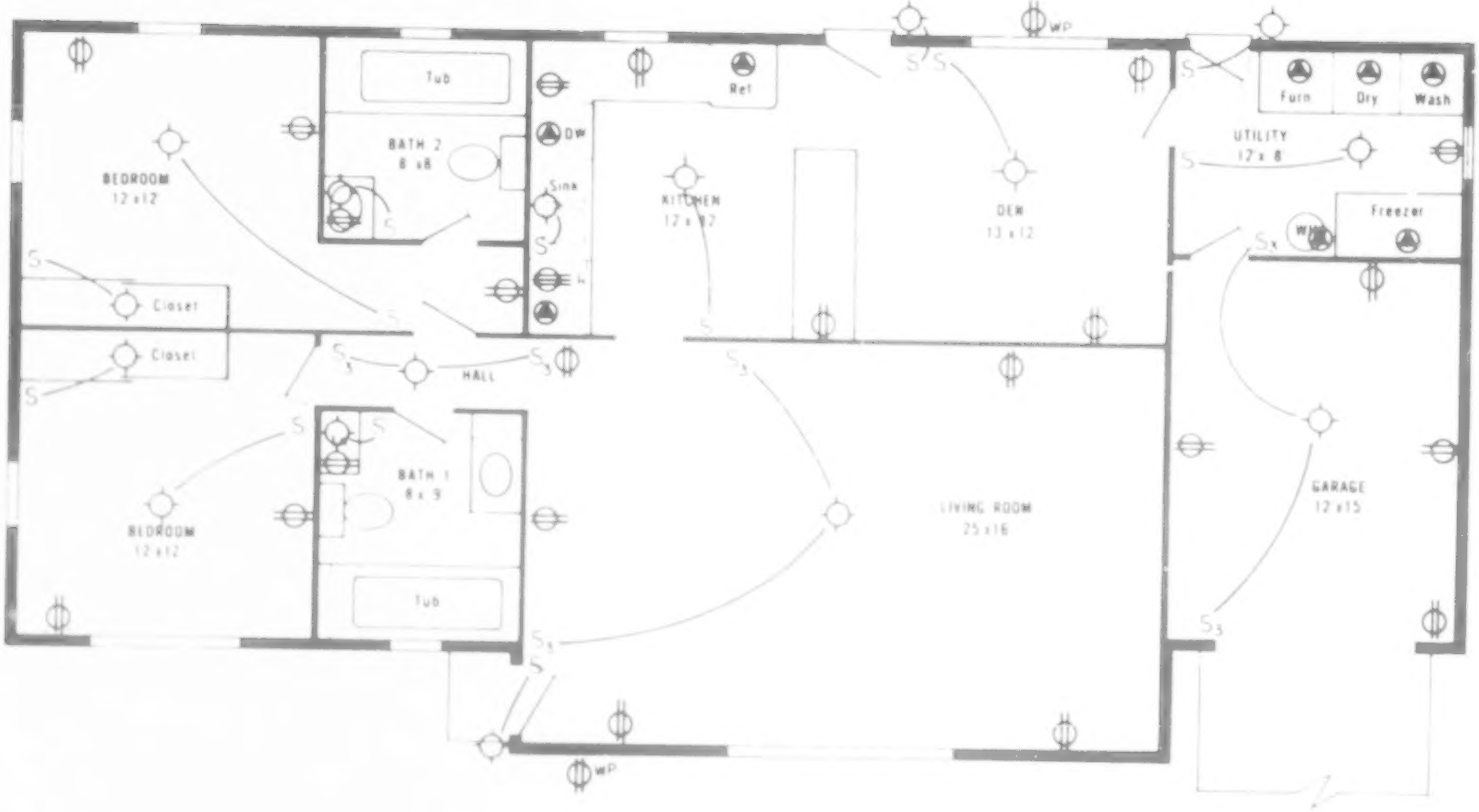
Switch And Pilot

S_w

Weatherproof Switch

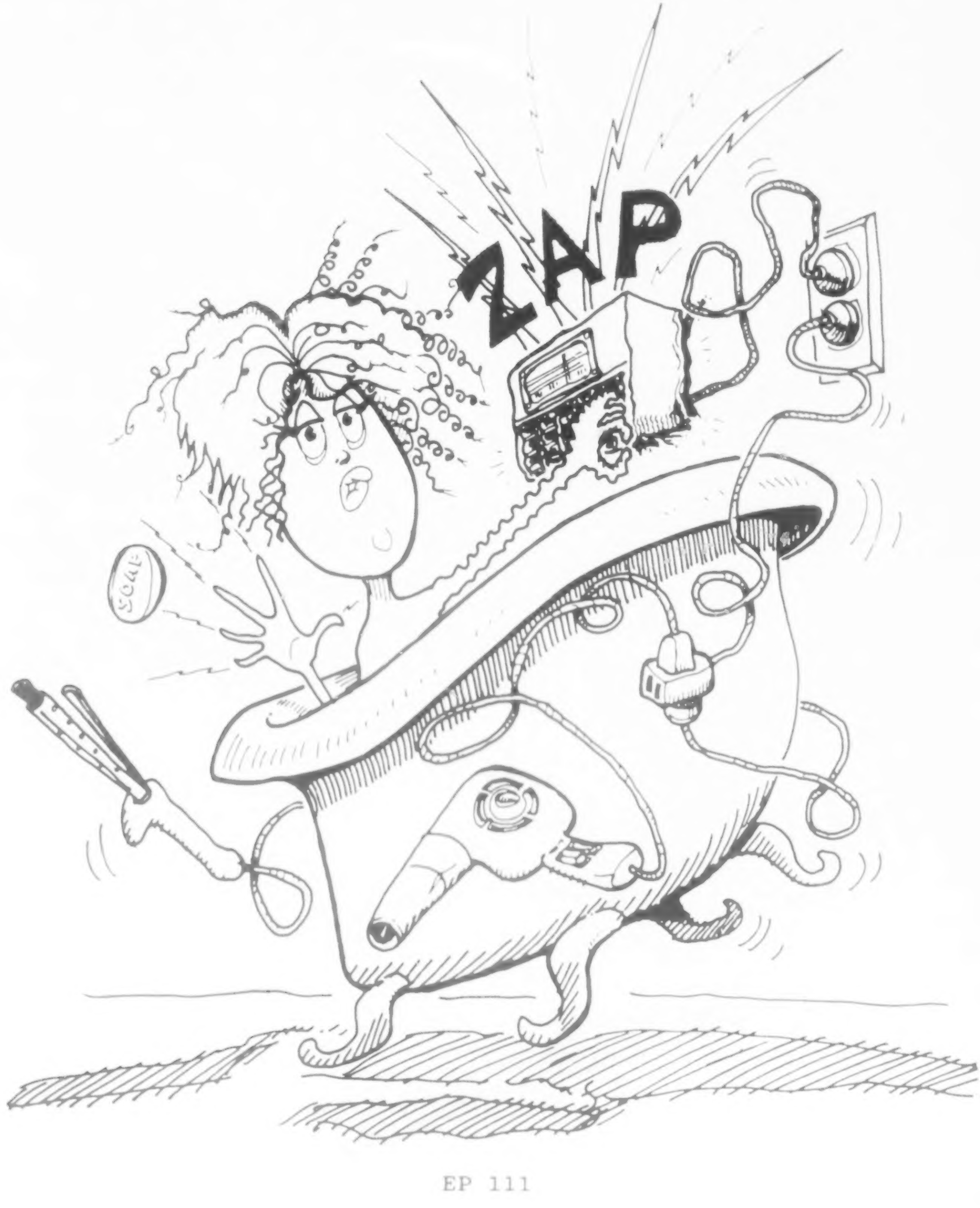
EP 107

Planning Outlets and Switches

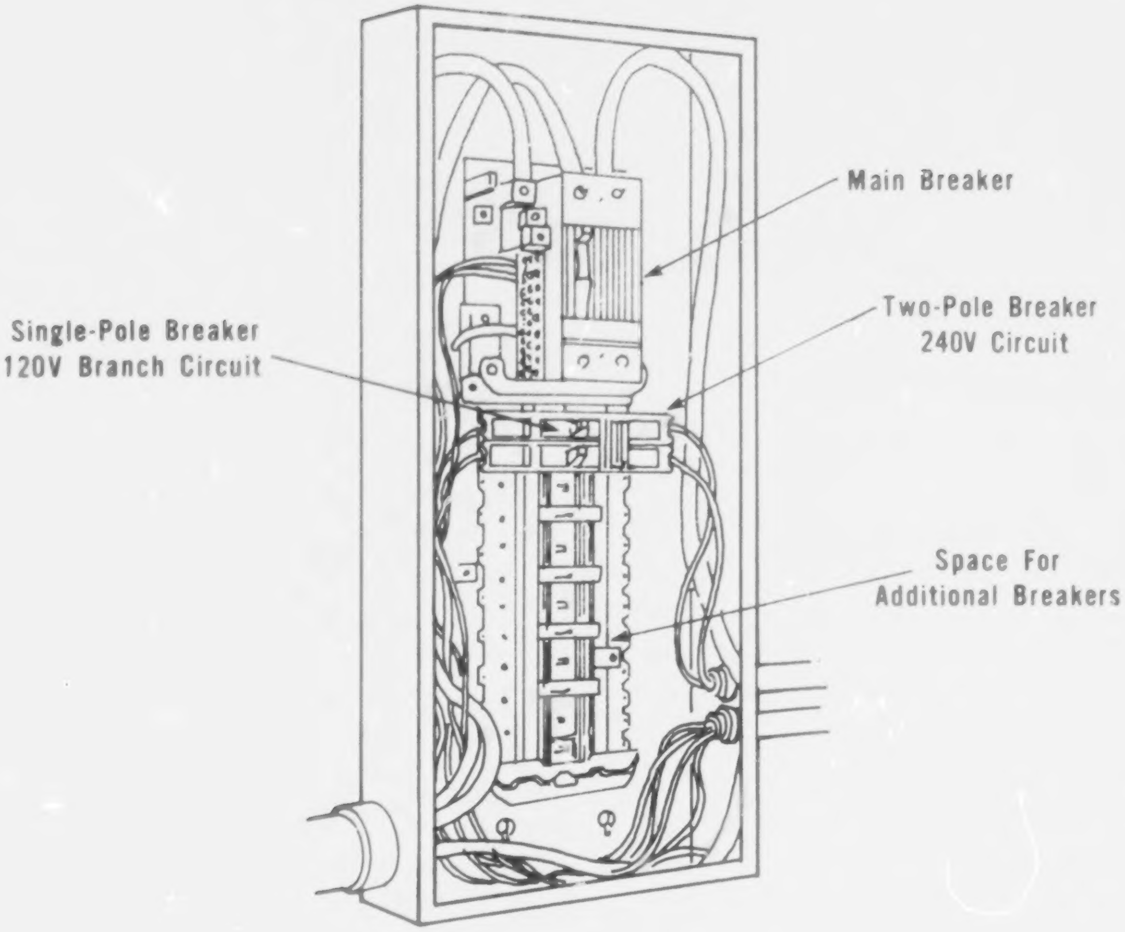

Tub
Ref
BATH 2
8 x8
DW
Sink
BEDROOM
12 x12
KITCHEN
12 x 12
DEN
13 x 12
WP
Furn
Dry
Wash
UTILITY
12 x 8
Freezer
WH
Closet
Closet
HALL
BATH 1
8 x 9
Tub
BEDROOM
12 x12
LIVING ROOM
25 x16
GARAGE
12 x15
WP

TM 4

Never Locate Outlets Near Tub or Shower

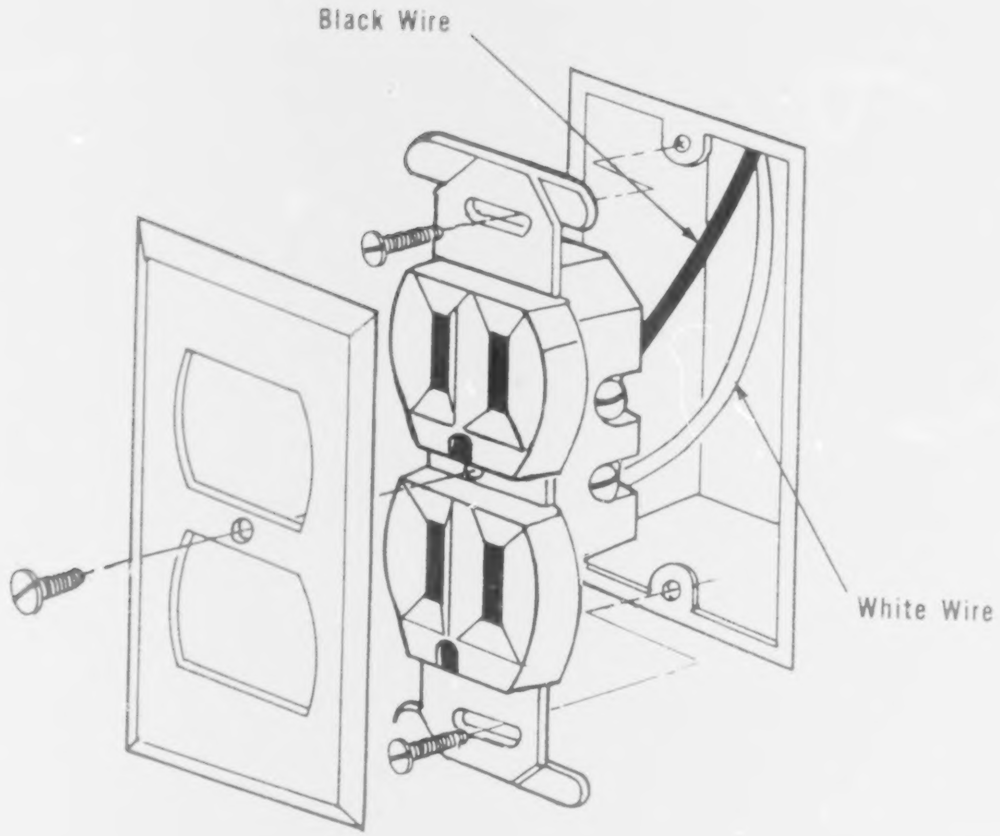


Entrance Panel

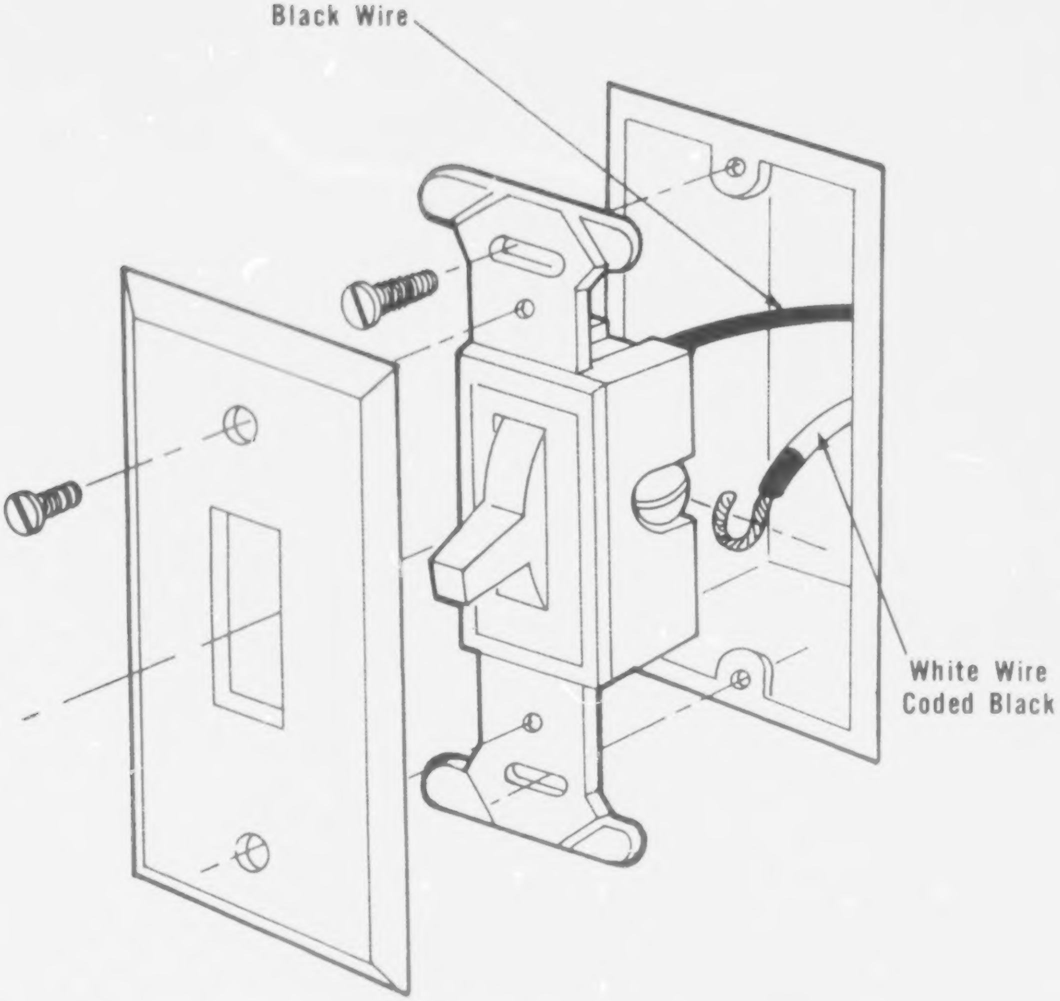

Main Breaker
Single-Pole Breaker
120V Branch Circuit
Two-Pole Breaker
240V Circuit
Space For
Additional Breakers

Service Entrance, 200-Ampere Capacity

Duplex Receptacle


Black Wire
White Wire

Single-Pole Switch


Black Wire
White Wire Coded Black

Dimmer Switch

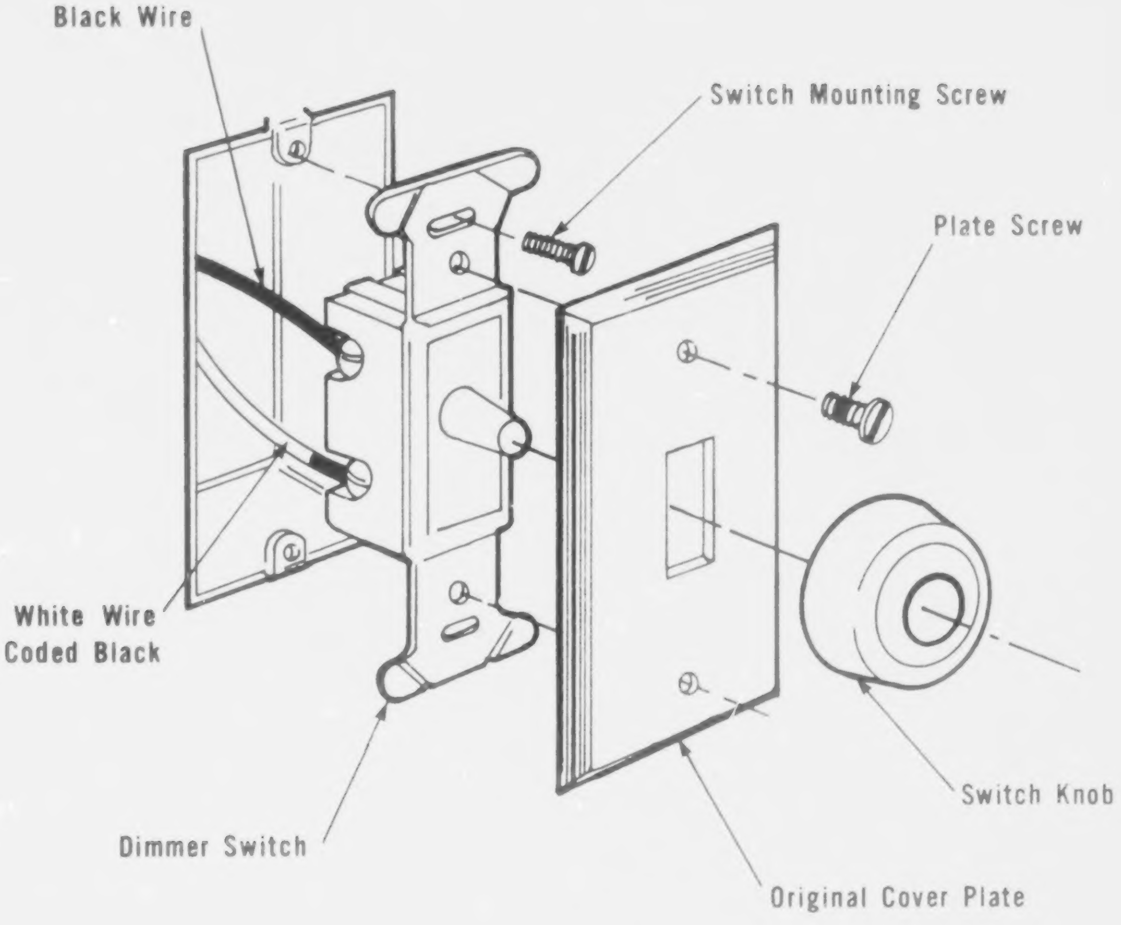

Black Wire
Switch Mounting Screw
Plate Screw
White Wire
Coded Black
Dimmer Switch
Original Cover Plate
Switch Knob

FIGURE GENERAL PURPOSE BRANCH CIRCUITS NEEDED

Directions: Using the information given, figure the number of general purpose circuits the house will need.

House has 42 general purpose outlets
No more than 9 outlets per circuit

A. ____________ number of outlets

B. Divided by the number of outlets allowed per circuit

____

C. Equals number of circuits______________

Remember: Any fraction of a number counts as one circuit. So 4.6 circuits equals

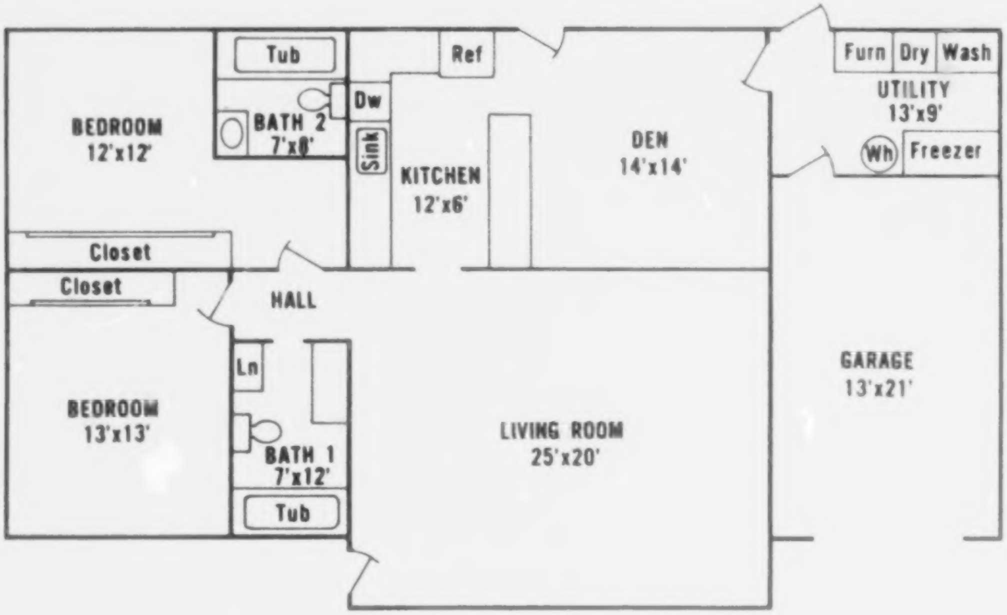
D. ____________ actual number of general purpose circuits

Completion of this assignment sheet partially fulfills competency D-4 of Building Maintenance.

AS 2

DRAW A WIRING PLAN

Directions: Draw a wiring plan on the floor plan below. Put in all outlets, lights, switches and special purpose outlets. Use the information sheet to help determine how many outlets, what type switches and other help you may need.


Tub
Ref
Furn
Dry
Wash
BEDROOM 12'x12'
BATH 2 7'x8'
Dw
UTILITY 13'x9'
Sink
KITCHEN 12'x6'
DEN 14'x14'
Wh
Freezer
Closet
Closet
HALL
Ln
GARAGE 13'x21'
BEDROOM 13'x13'
LIVING ROOM 25'x20'
BATH 1 7'x12'
Tub

Completion of this assignment sheet partially fulfills competency D-4 of Building Maintenance.

ANSWERS TO ASSIGNMENT SHEETS 1 - 2

Assignment Sheet 1

A. 42 = number of outlets
B. 9 = number of outlets allowed per circuit
C. 4.6 = number of circuits
D. 5 = actual number of general purpose circuits

Assignment Sheet 2

Evaluated to the satisfaction of the instructor

MOUNT ELECTRICAL BOXES

Equipment:

Outlet box
Junction box
Claw hammer
16 d box nails
Safety glasses

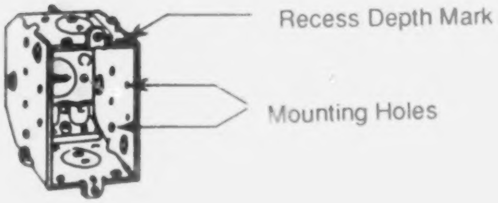
Procedure:

Evaluation
3 2 1 N

1. Locate desired position of outlet box. ___ ___ ___ ___

2. Locate box mounting holes and recess depth mark on box. ___ ___ ___ ___

(Note: Recess depth mark is a slight indention approximately 1/4 inch from box opening.)



3. Decide which nail holes should be used. ___ ___ ___

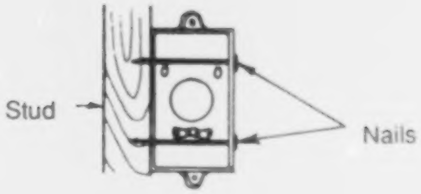
4. Hold box in desired position with recess depth mark even with edge of stud. ___ ___ ___ ___

5. Drive nails through holes into stud until nails are snug against the box. ___ ___ ___ ___

6. Check box to be sure it is held tightly in place. ___ ___ ___ ___

7. Repeat steps 1 - 6 for mounting junction box. ___ ___ ___ ___

Example:



8. Have instructor check your work. ___ ___ ___ ___

9. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

INSTALL NON-METALLIC (NM) CABLE IN ELECTRICAL BOXES

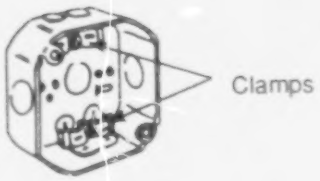
Equipment:

Lineman pliers
Conventional screwdriver
12/2 NM cable with ground wires
2 NM cable connectors
Brace and 3/4-inch bit

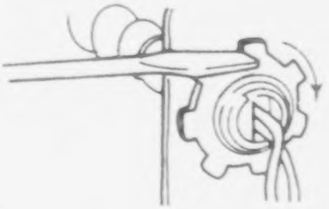
Procedure: Evaluation
3 2 1 N

1. Use mounted boxes from JS 1. ___ ___ ___ ___
2. Remove knockout from electrical boxes. ___ ___ ___ ___
3. Remove locknut from connectors. ___ ___ ___ ___

(Note: Boxes may have clamps for holding cable inside and connectors may not be necessary.)



4. Insert connector in knockout hole. ___ ___ ___ ___
5. Screw locknut on connector. ___ ___ ___ ___
6. Tighten locknut with screwdriver. ___ ___ ___ ___



7. Have instructor check your work. ___ ___ ___ ___

8. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

INSTALL DUPLEX RECEPTACLE

Equipment:

Wire stripper
Utility knife
Conventional screwdriver
Long-nose pliers
Duplex receptacle
14-2 W/G cable (minimum)
Safety Glasses

Procedure:

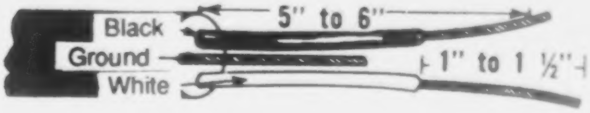
Evaluation
3 2 1 N

1. Remove about 6 inches of outside insulation from the end of the cable with the utility knife. ___ ___ ___ ___

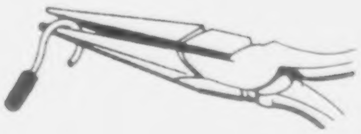
   (CAUTION: Do not cut the insulation on the wires under the outside insulation.)

2. Remove 1 to 1 1/2 inches of insulation from the two conductors using the wire stripper. ___ ___ ___ ___

   (Note: Be sure to use the proper gauge hole on the stripper.)



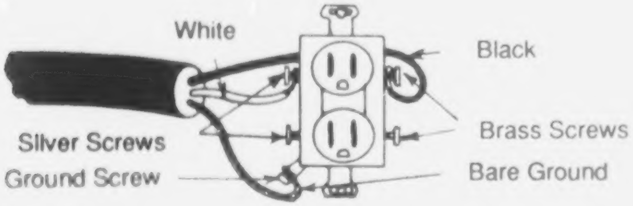
3. Make a loop on the end of each wire using the long-nose pliers. ___ ___ ___ ___



4. Using the screwdriver, attach the wires to the 15 A. receptacle as shown below. ___ ___ ___ ___

   (Note: Be sure the wire loop is on the screw in the clockwise position.)

   Example:


White
Black
Brass Screws
Silver Screws
Ground Screw
Bare Ground

5. Have instructor check your work. ___ ___ ___ ___

6. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

INSTALL SINGLE-POLE SWITCH

Equipment:

Wire stripper
Utility knife
Conventional screwdriver
Single-pole switch
Long-nose or chain-nose pliers
Safety glasses

Procedures:

Evaluation
3 2 1 N

1. Use cable at junction box end of JS 2. __ __ __ __

2. Remove about 6 inches of outer insulation from the end of the cable using utility knife. __ __ __ __

   (CAUTION: Do not cut the insulation on the wires under the outside insulation.)

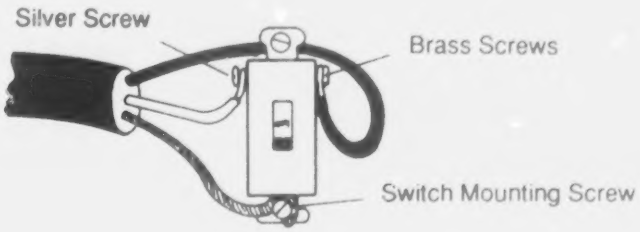
3. Remove 1 to 1 1/2 inches of insulation from the two conductors using the wire stripper. __ __ __ __

   (Note: Be sure to use the proper gauge hole on the stripper.)

4. Make a loop on the end of each wire using the long-nose or chain-nose pliers. __ __ __ __

5. Attach wires to the switch as shown below. __ __ __ __

   Example:



6. Connect ground wire behind switch mounting screw. ____ ____ ____ ____

7. Have instructor check your work. ____ ____ ____ ____

8. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ____ ____ ____ ____

Average of above evaluations* ____ ____ ____ ____

---

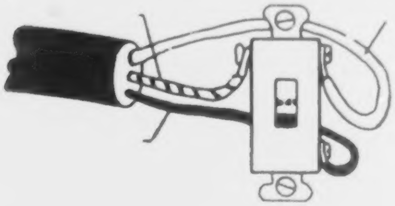
*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

INSTALL THREE-WAY SWITCH

Equipment:

Utility knife
Wire stripper
Conventional screwdriver
Three-way switch
Three-wire NM cable
Chain-nose or long-nose pliers
Safety glasses

Procedures:	Evaluation			
	3	2	1	N
1. Strip 6 inches of outer insulation off cable with utility knife.				
2. Strip 1 1/2 inches off end of each wire.				
3. Make loop on end of each wire.				
4. Connect wires to switch as shown below.				



5. Have instructor check your work.				
6. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials.				
Average of above evaluations*				

*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

INSTALL A DIMMER SWITCH

Equipment:

Wire stripper
Utility knife
Conventional screwdriver
Dimmer switch
Long-nose or chain-nose pliers
Safety glasses

Procedures: Evaluation
3 2 1 N

1. Use cable at junction box end of JS 2. ___ ___ ___ ___

2. Remove about 6 inches of outer insulation from the end of the cable using utility knife. ___ ___ ___ ___

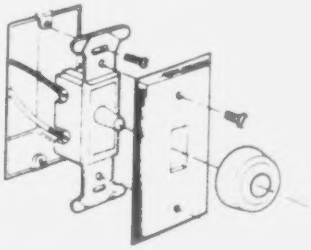
   (CAUTION: Do not cut the insulation on the wires under the outside insulation.)

3. Remove 1 to 1 1/2 inches of insulation from the two conductors using the wire stripper. ___ ___ ___ ___

   (Note: Be sure to use the proper gauge hole on the stripper.)

4. Make a loop on the end of each wire using the long-nose or chain-nose pliers. ___ ___ ___ ___

5. Attach wires to the switch as shown below. ___ ___ ___ ___



6. Connect ground wire behind switch mounting screw. ___ ___ ___ ___

7. Have instructor check your work. ___ ___ ___ ___

8. **As directed by instructor, prepare for next job sheet or clean up area and return tools and materials.** ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

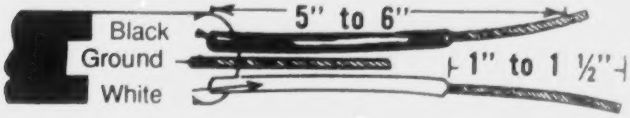
*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

INSTALL DUPLEX APPLIANCE RECEPTACLE

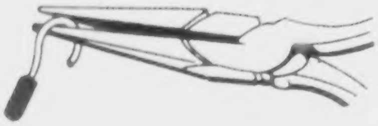
Equipment:

Wire stripper
Utility knife
Conventional screwdriver
Long-nose pliers
Duplex receptacle
12-2 w/g cable (minimum)
Safety glasses

Procedures:	Evaluation 3 2 1 N
1. Remove about 6 inches of outside insulation from the end of the cable with the utility knife.	__ __ __ __
(CAUTION: Do not cut the insulation on the wires under the outside insulation.)	
2. Remove 1 to 1 1/2 inches of insulation from the two conductors using the wire stripper.	__ __ __ __
(Note: Be sure to use the proper gauge hole on the stripper.)	

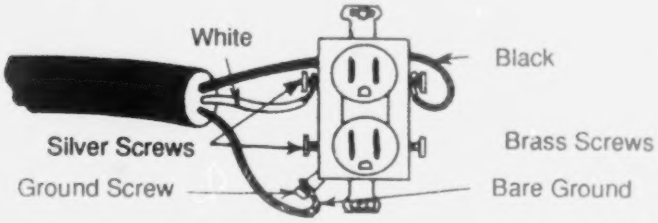


3. Make a loop on the end of each wire using the long-nose pliers.	__ __ __ __



4. Using the screwdriver, attach the wires to the 20A receptacle as shown below. ____ ____ ____ ____

(Note: Be sure the wire loop is on the screw in the clockwise position.)


White
Black
Silver Screws
Brass Screws
Ground Screw
Bare Ground

5. Have the instructor check your work. ____ ____ ____ ____

6. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ____ ____ ____ ____

Average of above evaluations* ____ ____ ____ ____

*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

INSTALL 240-VOLT APPLIANCE CIRCUIT

Equipment:

Wire stripper
Utility knife
Conventional screwdriver
Chain-nose pliers
240V receptacle (30A or 50A)
12-3 W/G cable (minimum)
Safety glasses

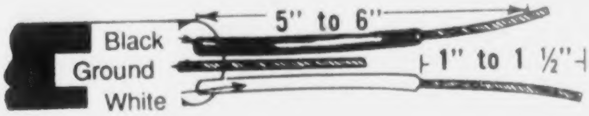
Procedure: Evaluation
3 2 1 N

1. Remove about 6 inches of outside insulation from the end of the cable with the utility knife. ___ ___ ___ ___

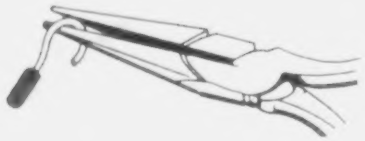
(CAUTION: Do not cut the insulation on the wires under the outside insulation.)

2. Remove 1 to 1 1/2 inches of insulation from the two conductors using the wire stripper. ___ ___ ___ ___

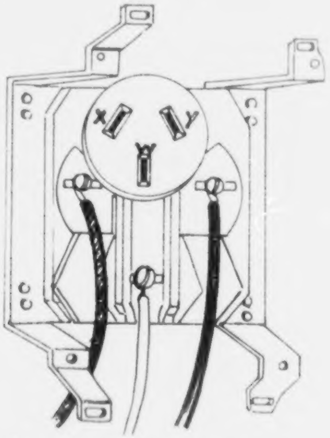
(Note: Be sure to use the proper gauge hole on the stripper.)



3. Make a loop on the end of each wire using the long-nose pliers. ___ ___ ___ ___



4. Using the screwdriver, attach the wires to the 20-amp receptacle as shown below. — — — —



5. Have the instructor check your work. — — — —

6. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

Average of above evaluations* — — — —

*This average is the student's partial evaluation for competency D-4 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 4: WIRING CIRCUITS TO CODE 115-VOLT (15 AND 20 AMP) AND 240-VOLT

LESSON TEST

Part 1. Match the electrical terms below to the correct definition by placing the letter in the blank.

A. Branch circuit
B. Conduit
C. Wiring plan
D. Adapter
E. Breaker
AB. Special purpose outlets

______ 1. A safety switch that connects the branch circuits to the power source

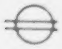
______ 2. All the outlets and receptacles connected on one branch

______ 3. Any outlet for appliances that uses 240-volts or motors larger than 1/3 horsepower

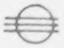
______ 4. A drawing of the house floor plan showing switch wiring and outlets

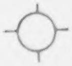
Part 2. Identify the electrical symbols by placing the letter in the correct blank.

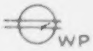
A. Switch wiring
B. Three-way switch
C. Single-pole switch
D. Weatherproof duplex outlet
E. Ceiling light outlet
AB. 240-volt outlet
AC. Special purpose outlet
AD. Duplex receptacle outlet

______ 5. 

______ 6.

______ 7. 

______ 8. 

______ 9. 

_____10. S

_____11. S_3

_____12. S———

Part 3. Match the terms below to the correct definitions by placing the letter in the blank.

A.	Outlet box	AE.	Neutral wire
B.	Junction box	BC.	Terminal
C.	Hot wire	BD.	Three-way switch
D.	Wire size	BE.	Wiring plan
E.	Cord	CD.	Branch circuit
AB.	Electrical cable	CE.	Duplex receptacle
AC.	Wire	DE.	Single-pole switch
AD.	Ground wire		

_____13. All the outlets and receptacles connected on one leg

_____14. A single conductor

_____15. Usually bare or green wire that connects circuit to earth for safety

_____16. Several small wires put together in an insulating cover and usually very flexible

_____17. Usually black but can be any color except green and always has voltage applied

_____18. Usually a white wire and serves as a return for current

_____19. Measure of wire diameter and called the "gauge" of wire

_____20. A covered outlet box used to enclose splices within a circuit

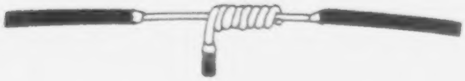
_____21. A drawing of the house floor plan showing wiring

_____22. A connection between the wires and electrical devices usually fastened with a screw or clip

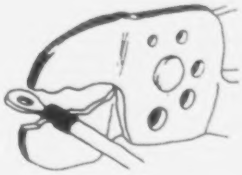
Part 4. Identify the splices and connections below by placing the letter of each description in the blank beside its drawing.

A. Wire nut
B. Solderless terminal
C. Pigtail splice
D. Tap splice
E. Terminal loop
AB. Two-wire splice

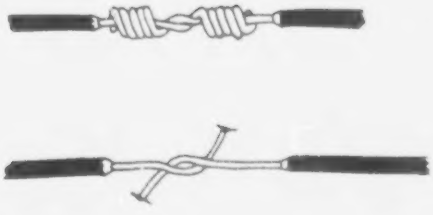
_____23.



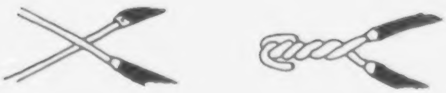
_____26.



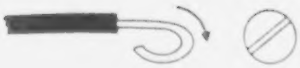
_____24.



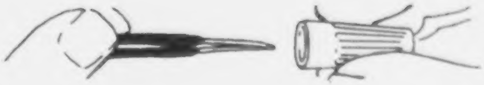
_____25.



_____27.



_____28.



Part 5. Place an "X" on the blank beside each statement that correctly states a reason for wiring failure.

_____29. Blown fuse

_____30. Tripped circuit breaker

_____31. Burned out bulbs

_____32. Flickering and dim lights

_____33. Poorly operating appliances

_____34. Overload circuits

_____35. Shorted circuits

_____36. Broken or loose wires

_____37. Faulty equipment

Part 6. Place an "X" on the blank beside each correct statement about planning of outlets and switches.

_____38. At least one ceiling light in living room or bedroom

_____39. Duplex outlets every 4 feet in work area of kitchen

_____40. Put outlets near tub in bathroom

_____41. Range in kitchen should be a special purpose outlet

Part 7. Identify the size of the cables below by writing the two numbers in the blank that describe each wire.

Example: 18/3 g. = 18 gauge, 3 conductors

__________42. 14 gauge, 2 conductors

__________43. 10 gauge, 3 conductors

__________44. 12 gauge, 3 conductors

__________45. 16 gauge, 2 conductors w/ground

Part 8. List the three types of branch circuits.

46.

47.

48.

Part 9. Figure the number of branch circuits needed with the information below.

A house has 32 general purpose outlets

___________49. Number of outlets
(9 outlets per circuit)

___________50. Number of circuits

___________51. Actual number of branch circuits

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

ANSWERS TO UNIT I, LESSON 4 TEST

Part 1.

1. E
2. A
3. AB
4. C

Part 2.

5. AD
6. AC
7. D
8. C
9. B
10. E
11. AB
12. A

Part 3.

13. CD
14. AC
15. AD
16. E
17. C
18. AE
19. D
20. B
21. BE
22. BC

Part 4.

23. D
24. AB
25. C
26. B
27. E
28. A

Part 5.

29. A
30. A
31. B
32. A
33. A
34. A
35. A
36. A
37. A

Part 6.

38. B
39. B
40. B
41. B

Part 7.

42. 14/2
43. 10/3
44. 12/3
45. 16/2

Part 8.

46. General purpose
47. Small appliance
48. Special purpose

Part 9.

49. 32
50. 3.5
51. 4

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 5: LOW-VOLTAGE WIRING

LESSON OBJECTIVE

After completion of this lesson, the student will be able to UNDERSTAND TERMS AND PROCESSES CONNECTED WITH LOW-VOLTAGE WIRING and BE ABLE TO WIRE VARIOUS LOW-VOLTAGE CIRCUITS. Mastery will be evidenced by satisfactory completion of job sheets and by scoring ___________ percent on the lesson test.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Match terms associated with low-voltage wiring to the correct definitions.
2. Identify the parts of a low-voltage lighting system.
3. Describe the process that takes place during a low-voltage lighting circuit off/on cycle.
4. Describe the process that takes place during the energizing of a chime circuit.
5. Describe the manual fan switching circuit.
6. Describe the circuit that is created when the thermostat system switch is in the cool position and the fan switch is in automatic.
7. Describe the circuit that is created when the system switch is in the heat position.
8. Wire a two-switch, low-voltage lighting circuit.
9. Wire a two-button chime circuit.
10. Install a wall thermostat.

Completion of the requirements of this lesson fulfills competency D-5 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 5: LOW-VOLTAGE WIRING

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
   1. Parts of a low-voltage lighting system
   2. Thermostat--heating circuit with automatic fan control

D. Job sheets
   1. Wire a two-switch low-voltage lighting circuit
   2. Wire a two-button chime circuit

E. Lesson test

F. Answers to lesson test

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 5: LOW-VOLTAGE WIRING

INFORMATION OUTLINE

I. Terms and definitions

- A. Transformer--an electrical device used to step up or step down a primary voltage to a desired secondary voltage
- B. Momentary contact switch--a switch that is closed or open only while the operator touches it
- C. Solenoid--electromagnetic cylinder that will pull a movable plunger into it when current is applied
- D. Relay--electromagnetic device for remote or automatic control
- E. Thermostat--a device that senses temperature variations from a set point and, in turn, acts to control a circuit
- F. Pull-push solenoid--solenoid with two electromagnetic circuits that will pull or push a plunger depending on which magnet has current applied to it

II. Parts of a low voltage lighting system (TM 1)

- A. 24 volt transformer
- B. Low-voltage lighting relay
- C. Momentary contact switch
- D. Low-voltage cable

III. Low-voltage lighting circuit off/on cycle

- A. "On" switch is pushed
  - 1. Circuit is completed to closing movement of solenoid in relay
  - 2. Core is moved and circuit is completed

B. "Off" switch is pushed
  1. Circuit is completed to opening movement of solenoid in relay
  2. Core is moved and circuit is opened

IV. Process that takes place during the energizing of a chime circuit

(Note: This is a front door signal on a two-note chime)

A. Button is pushed
  1. Circuit is completed to solenoid
  2. Plunger is drawn down to chime and sound is made

B. Button is released
  1. Circuit is open
  2. Spring pulls plunger up to upper chime and another sound is made

V. Manual fan switching circuit

A. Current from transformer goes to fan-control switch

B. Closed switch directs current to fan relay control coil

(Note: This closes normally open contacts and the fan motor receives line voltage and runs)

C. Common conductor returns current to transformer

VI. Thermostat system switch in cool position, fan switch in automatic (TM 2)

A. Current from transformer goes to mercury bulb switch

B. From mercury switch, current goes to the system switch

C. Current splits at the system switch:
  1. One split goes to fan switch
    a. Through closed automatic contacts
    b. To fan relay control coil
    (Note: This closes normally open relay contacts and starts fan motor)
    c. Back to transformer
  2. One split goes to the cooling contactor
    a. Through cooling contactor coil
    (Note: This closes normally open contacts and compressor starts)
    b. Back to transformer

VII. System switch in heat position

A. Current from transformer goes to mercury bulb switch

B. Through mercury bulb switch to system switch

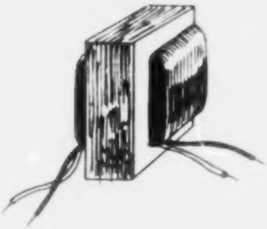
C. Through closed contacts of heat circuit

D. To heating contactor or control valve coil

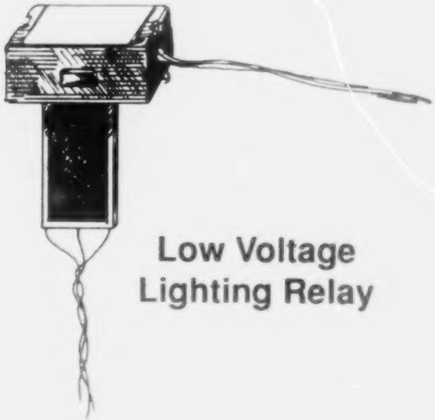
(Note: This closes normally open relay contacts and energizes elements and low-speed fan control --on gas models a plenum switch energizes fan motor)

E. Back to transformer

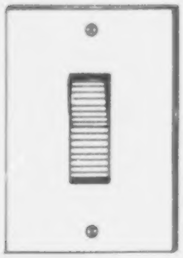
Parts of a Low Voltage Lighting System



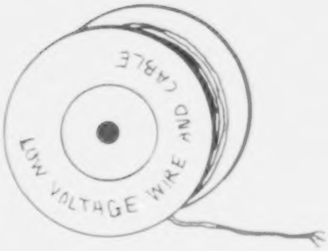
24 Volt Transformer



Low Voltage
Lighting Relay

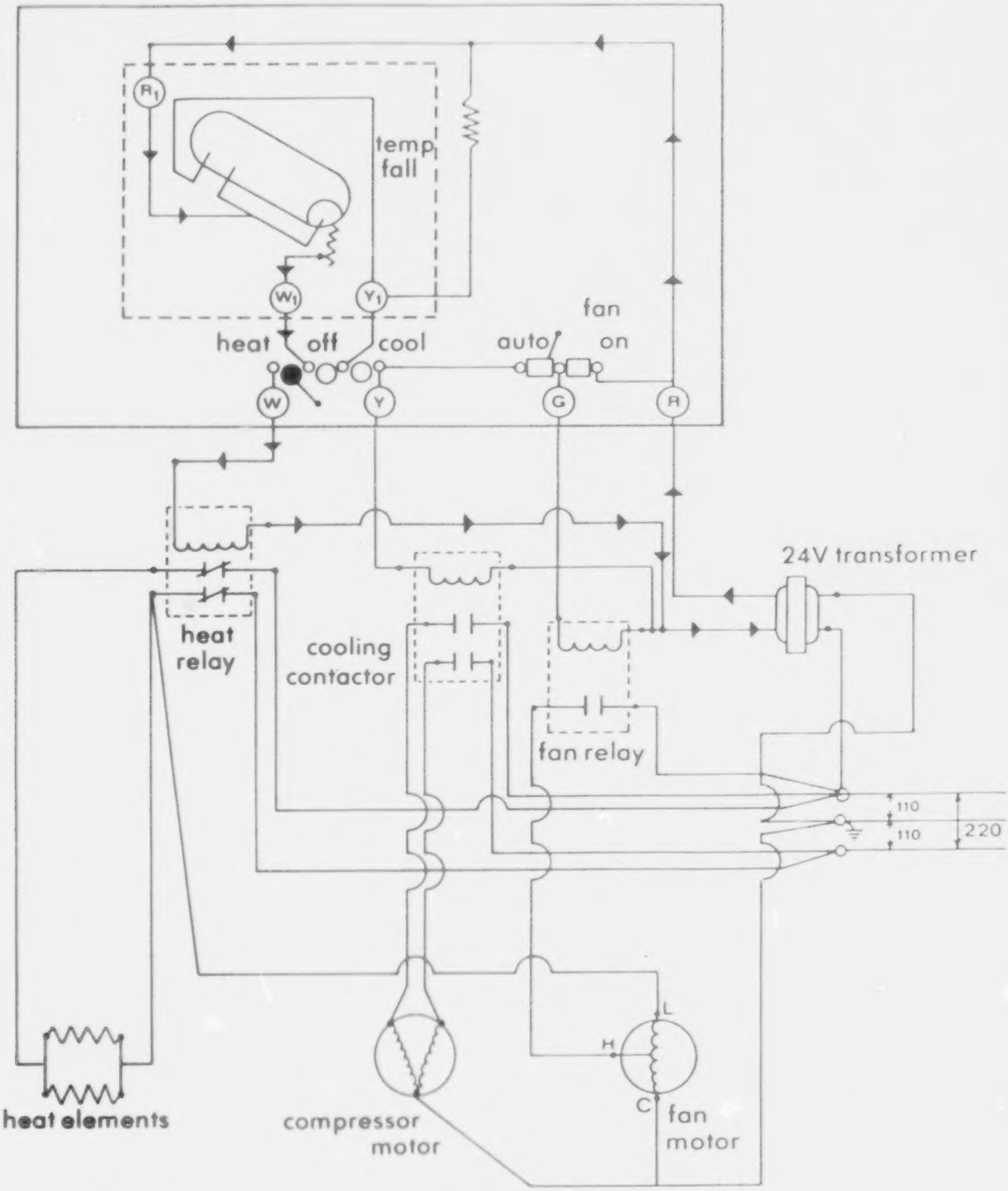


Momentary Contact Switch


LOW VOLTAGE WIRE AND CABLE

Low Voltage Cable

Thermostat
Heating Circuit with Automatic Fan Control


R1
temp fall
W1
Y1
heat
off
cool
fan
auto
on
W
Y
G
R
24V transformer
heat relay
cooling contactor
fan relay
110
110
220
L
H
C
heat elements
compressor motor
fan motor

JS 1

WIRE A TWO-SWITCH LOW-VOLTAGE LIGHTING CIRCUIT

Equipment:

120-24v step-down transformer
1/2" or larger wood bit
One 24v lighting relay
Two low voltage lighting switches
One octagon box and hanger
Two single gang plaster rings
(Note: Two regular device boxes could be used.)
Three-wire low voltage cable
12-2G or 14-2G NM cable
Wire connectors
Light socket
Incandescent bulb
Staples
120v power supply
2" x 4" mockup wall or shop board
Fasteners to secure boxes and hanger bar
Electrician's hammer
Flat blade screwdriver
Lineman's pliers
Long-nose pliers
Knife
Wire strippers
Drill motor and bit or brace
(Note: An extension cord will be needed if a drill motor is used.)

Safety glasses
Portable GFI

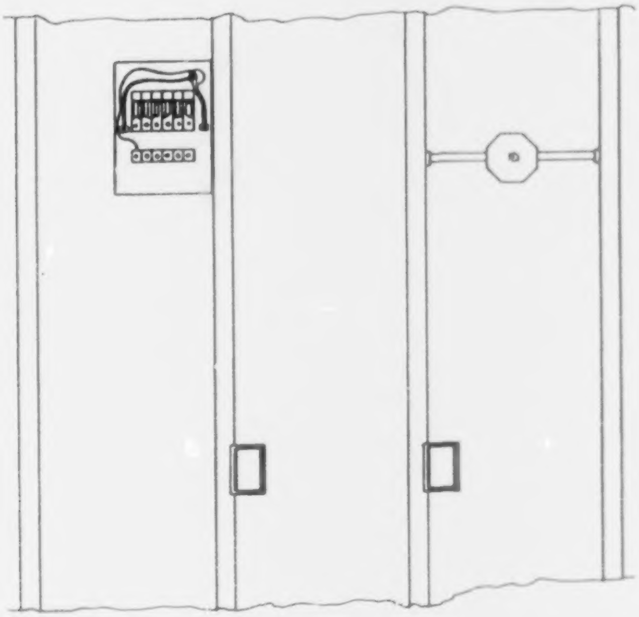
Procedure:

Evaluation
3 2 1 N

1. Put on safety glasses and gather tools and equipment. __ __ __ __

2. Mount box and plaster rings. — — — —

(Note: Use your GFI when drilling.)



3. Run 120 v supply cable from panel to lighting outlet box. — — — —

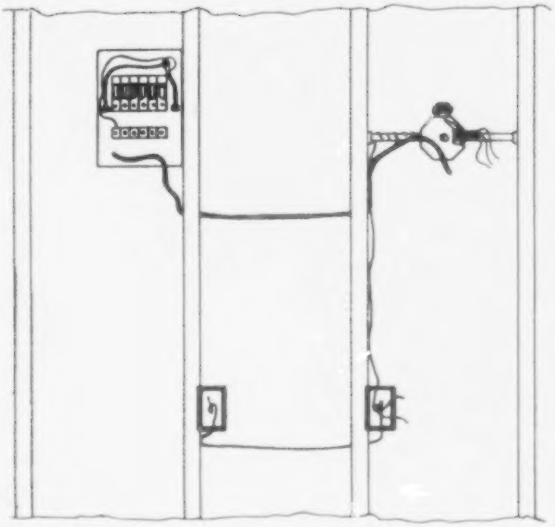
(Note: In this example the transformer will be mounted at the outlet box. In a residence it must be accessible.)

4. Mount transformer on the back or top of outlet box. — — — —

5. Install lighting relay. — — — —

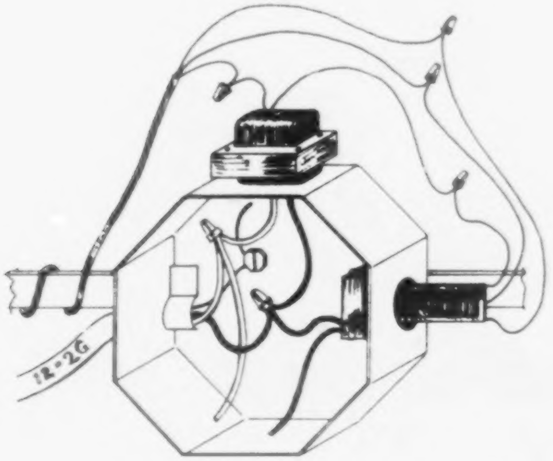
6. Drive the 16 penny nails in the center of the device ring openings at about the center of the stud. — — — —

7. Run cable. __ __ __ __



(Note: Wrap the cable around the bar hanger and around the nails.)

8. Make transformer and solenoid connections. __ __ __ __



(Note: One transformer lead is the switch leg, and one transformer lead goes to relay common. The remaining two relay leads should be labeled as off and on return legs for switch operation.)

9. Connect switch leg to common on both switches. ___ ___ ___ ___

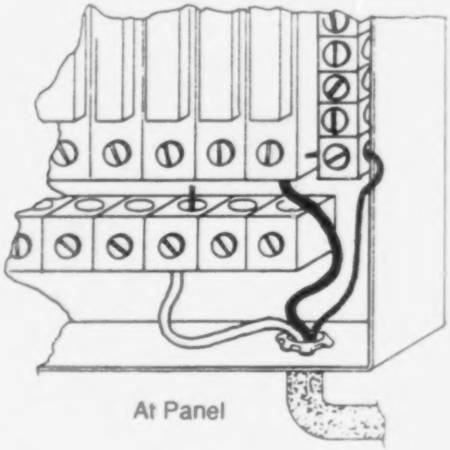
(Note: A pigtail is needed on the first connection to carry the switch leg to the second switch.)

10. Connect on and off return legs to appropriate switch terminals. ___ ___ ___ ___

11. Mount switches. ___ ___ ___ ___

12. Attach socket to neutral and relay 120v return leg. ___ ___ ___ ___

13. Make up panel. ___ ___ ___ ___



At Panel

14. Turn on breaker. ___ ___ ___ ___

15. Turn on at one switch and off at the other. ___ ___ ___ ___

16. Turn on at other switch and off at the other. ___ ___ ___ ___

17. Have instructor evaluate your work. ___ ___ ___ ___

18. Turn off breaker. ___ ___ ___ ___

19. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-5 of Building Maintenance.

WIRE A TWO-BUTTON CHIME CIRCUIT

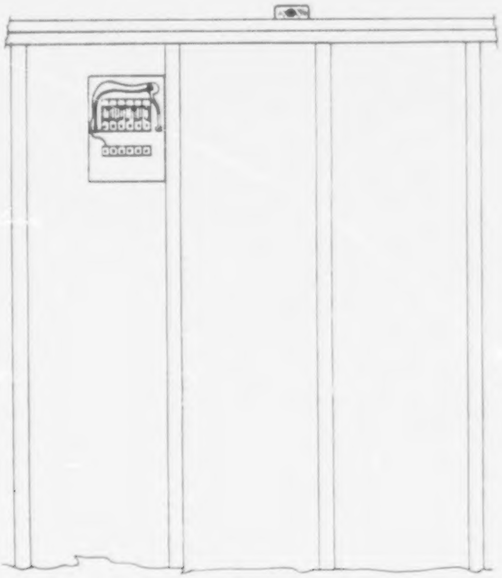
Equipment:

Two door bell buttons
18-3 and 18-2 bell wire cable
16 volt transformer
Chime with front and back call
12 or 14-2G NM cable
Electrician's hammer
Long-nose pliers
Flat-blade screwdriver
Cable staples
3/8" cable clamp
Stud wall or work board
120 volt power supply
Pocket knife
Wire strippers
Wire connectors
Octagon box and blank plate with 1/2" K.O.
3/4" x 10" metal tapping screws
Drill motor or brace
1/2" or larger wood bit
Extension cord
Header board (short piece of 1" x 6" or 2" x 4"
Four 16 penny nails
Safety glasses
GFI

Procedure:	Evaluation			
	3	2	1	N
1. Put on safety glasses and gather tools and equipment.	___	___	___	___

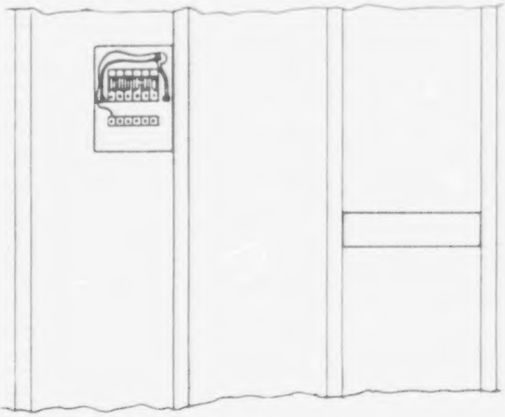
2. Mount box.

(Note: If mounted on a wall plate, this box must be above insulation. The best place to mount the transformer is a furnace closet so you can change it without getting into the attic.)

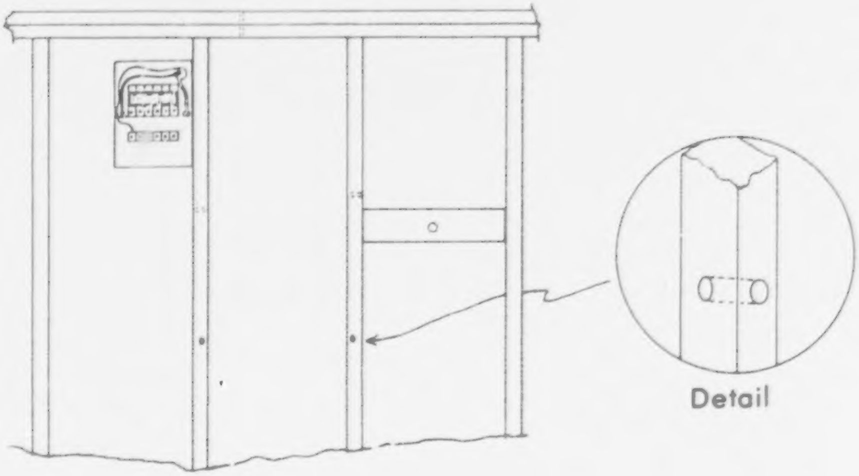


3. Mount header.

(Note: It must be mounted flush with wall surface.)

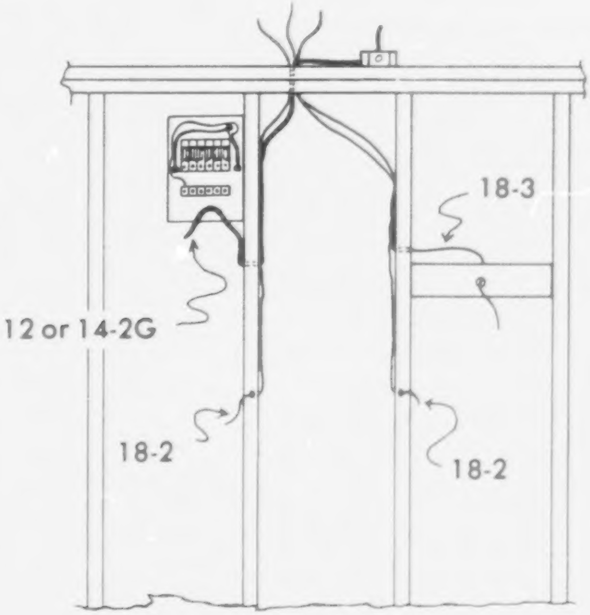


4. Drill holes. __ __ __ __



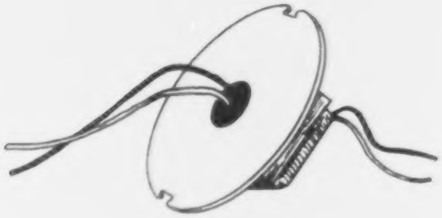
(Note: On a residential rough-in, button wires are drilled through at an angle in the door opening. Use GFI when drilling.)

5. Run cable. __ __ __ __


18-3
12 or 14-2G
18-2
18-2

EP 171

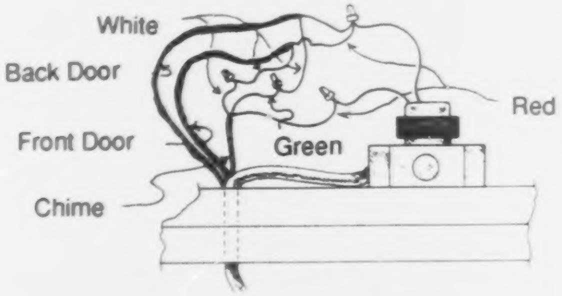
6. Mount transformer to blank plate. ____ ____ ____ ____



7. Connect transformer supply leads to cable from panel. ____ ____ ____ ____

8. Mount blank plate on octagon box. ____ ____ ____ ____

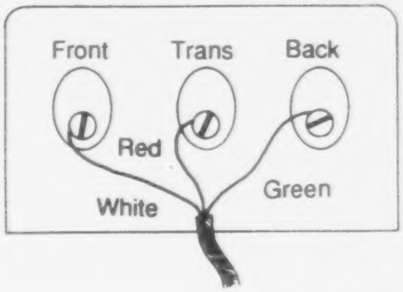
9. Make low voltage connections at transformer. ____ ____ ____ ____


White
Back Door
Front Door
Chime
Green
Red

10. Mount chime on header. ____ ____ ____ ____

(Note: Put cable through opening in sub-base before securing chime.)

11. Connect conductors to chime. ____ ____ ____ ____



12. Connect buttons. ____ ____ ____ ____

13. Connect conductors at panel. ____ ____ ____ ____

14. Turn on breaker. ____ ____ ____ ____

15. Push front button. ____ ____ ____ ____

    (Note: You should hear a two-tone chime.)

16. Push back button. ____ ____ ____ ____

    (Note: You should hear a one-tone chime.)

17. Have instructor evaluate your work. ____ ____ ____ ____

18. Turn off breaker. ____ ____ ____ ____

19. **As directed by instructor, prepare for next job sheet or clean up area and return tools and materials.** ____ ____ ____ ____

Average of above evaluations* ____ ____ ____ ____

*This average is the student's partial evaluation for competency **D-5 of Building Maintenance.**

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 5: LOW-VOLTAGE WIRING

LESSON TEST

Part 1. Match the terms below to the correct definitions.

A. Transformer
B. Momentary contact switch
C. Solenoid
D. Relay
E. Thermostat
AB. Pull-push solenoid

_____ 1. A device that senses temperature variations from a set point and, in turn, acts to control a circuit

_____ 2. Electromagnetic device for remote or automatic control

_____ 3. Electromagnetic cylinder that will move an iron plunger when current is applied

_____ 4. Solenoid with tow electromagnetic circuits that will pull or push a plunger depending on which magnet has current applied

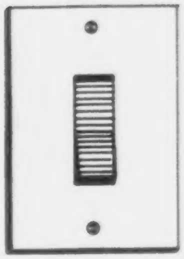
_____ 5. A switch that is closed or opened only while the operator touches it

_____ 6. An electrical device used to step up or step down a primary voltage to a desired secondary voltage

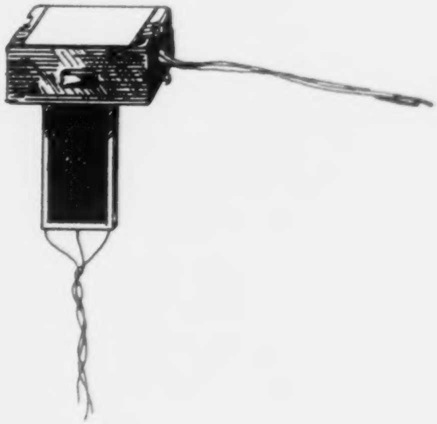
Part 2. Identify the parts of a low-voltage lighting system by matching the names below with their illustrations.

A. Low-voltage lighting relay
B. 24 volt transformer
C. Momentary contact switch
D. Low-voltage cable

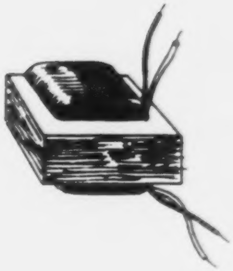
_____ 7.



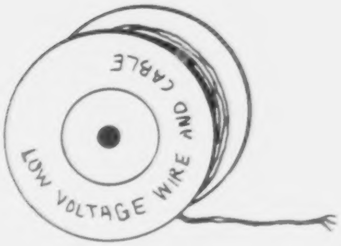
_____ 8.



_____ 9.



_____10.

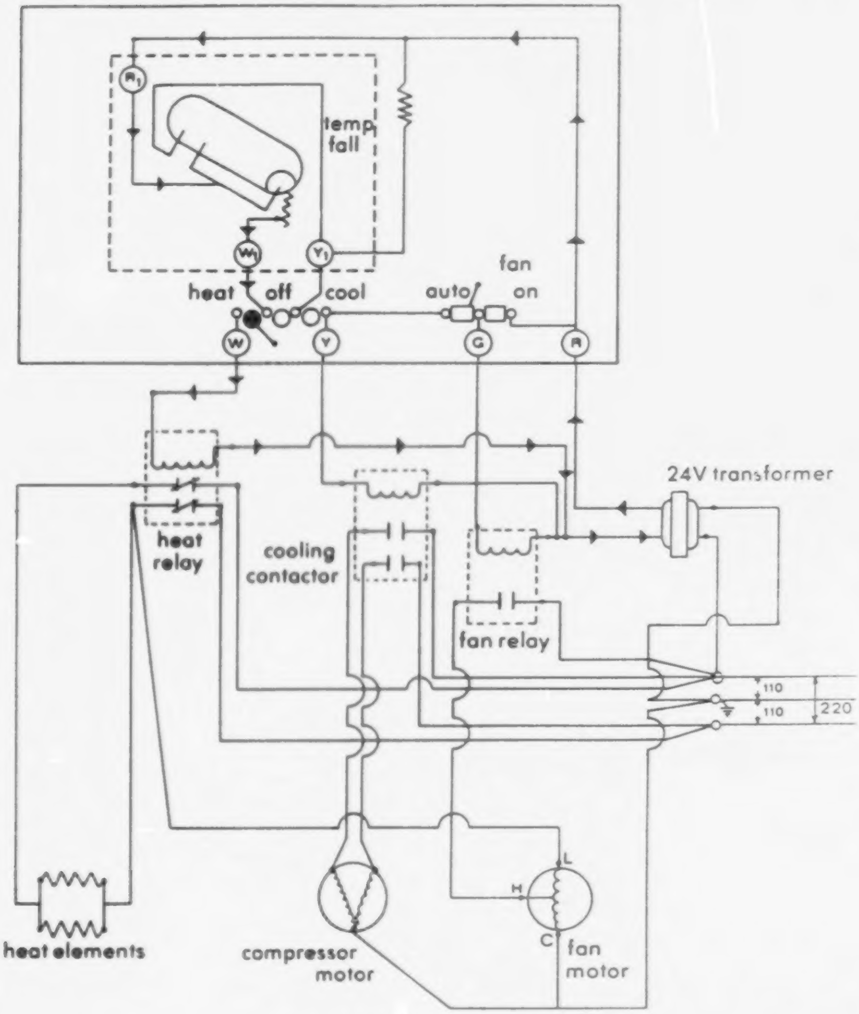

LOW VOLTAGE WIRE AND CABLE

Part 3.

11. Describe the process that takes place during a low voltage lighting circuit off/on cycle.

12. Describe the process that takes place during the energizing of a chime circuit.

13. Describe the manual fan switching circuit, referring to the following illustration.


R1
temp fall
W1
Y1
heat
off
cool
fan
auto
on
W
Y
G
R
24V transformer
heat relay
cooling contactor
fan relay
110
110
220
heat elements
compressor motor
L
H
C
fan motor

EP 178

14. Describe the circuit that is created when the thermostat system switch is in the cool position and the fan switch is in automatic. (Refer to the previous illustration.)

15. Describe the circuit that is created when the system switch is in the heat position. (Refer to the previous illustration.)

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

ANSWERS TO UNIT I, LESSON 5 TEST

Part 1.

1. E
2. D
3. C
4. AB
5. B
6. A

Part 2.

7. C

8. B

9. A

10. D

11. Description should include:

    A. "On" switch is pushed
        1. Circuit is completed to closing movement of solenoid in relay
        2. Core is moved and circuit is completed

    B. "Off" switch is pushed
        1. Circuit is completed to opening movement of solenoid in relay
        2. Core is moved and circuit is opened

12. Description should include:

    A. Button is pushed
        1. Circuit is completed to solenoid
        2. Plunger is drawn down to chime and sound is made

    B. Button is released
        1. Circuit is open
        2. Spring pulls plunger up to upper chime and another sound is made

13. Description should include:

    A. Current from transformer goes to fan-control switch

    B. Closed switch directs current to fan relay control coil

    C. Common conductor returns current to transformer

14. Description should include:

    A. Current from transformer goes to mercury bulb switch

    B. From mercury switch, current goes to the system switch

    C. Current splits at the system switch:
        1. One split goes to fan switch
            a. Through closed automatic contacts
            b. To fan relay control coil
            c. Back to transformer
        2. One split goes to the cooling contactor
            a. Through cooling contactor coil
            b. Back to transformer

15. Description should include:

    A. Current from transformer goes to mercury bulb switch

    B. Through mercury bulb switch to system switch

    C. Through closed contacts of heat circuit

    D. To heating contactor or control valve coil

    E. Back to transformer

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 6: USING ELECTRONIC TEST EQUIPMENT

LESSON OBJECTIVE

After completion of this lesson, the student will be able to USE A VOLTAGE METER AND VARIOUS OTHER TESTING DEVICES TO IDENTIFY COMMON ELECTRICAL PROBLEMS. Mastery will be evidenced by satisfactory completion of assignment sheets and job sheets, and by scoring ____________ percent on the lesson test.

SPECIFIC OBJECTIVES

1. Match terms associated with electronic test equipment to their correct definitions.
2. Identify the parts of a volt-ohm meter.
3. Demonstrate the use of a volt-ohm meter.
4. Demonstrate the use of a neon tester.
5. Demonstrate the use of a continuity tester.
6. Demonstrate the use of a clamp-on ammeter.
7. Discuss the care of testing devices.

Completion of the requirements of this lesson fulfills competency D-6 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 6: USING ELECTRONIC TEST EQUIPMENT

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
   1. Testing equipment
   2. The Ammeter

D. Assignment sheet
   1. List parts of a volt-ohm meter

E. Answers to assignment sheet

F. Job sheets
   1. Using the volt-ohm meter to test the voltage at a 125-volt wall outlet
   2. Using the volt-ohm meter to test a dry-cell battery
   3. Using the ammeter to check current of an operating circuit
   4. Using the neon tester to test a 120-volt circuit
   5. Using the continuity tester to check a house fuse

G. Lesson test

H. Answers to lesson test

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 6: USING ELECTRONIC TEST EQUIPMENT

INFORMATION OUTLINE

I. Terms and definitions

  A. Volt--a unit of measure of electrical pressure

  B. OHM--a unit of measure of electrical resistance

  C. Volt-ohm meter--a simple electrical measuring instrument used to troubleshoot electrical problems

  D. VAC--volts alternating current

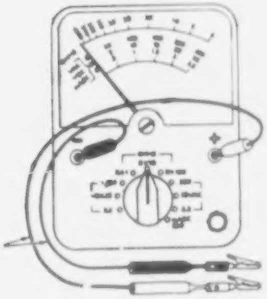
  E. VDC--volts direct current

  F. MADC--milliamps direct current

  G. Ohms scale--low ohms readings are at right, high at left

  H. symbol meaning infinity

II. The Volt-ohm meter (TM 2)



A. Ohms scale
   1. Has low ohms readings at right, high at left (the reverse of other scales)
   2. Multiply ohms reading by whatever number selector switch indicates (RX10 or RX100)
   3. Symbol at left (∞) stands for infinity--when needle points to it, ohms reading is higher than meter can measure

B. VAC, VDC, and MADC scales
   1. Read here for volts AC, volts DC, or milliamps DC (thousandths of an ampere)
   2. Selector switch shows which set of numbers to use --top, middle, or bottom
   3. When measuring unknown voltages, start with selector on the highest scale (250) and work down to achieve increased sensitivity and accuracy

C. Selector switch
   1. Rotate switch so that it points to quantity you want to measure
   2. Instead of selector switch, some low-priced meters have an array of jacks, each one corresponding to a different measurement

D. Test leads and jacks
   1. Always insert black lead in - jack, red lead in + jack (--jack is also called com or common)
   2. When testing a battery or other DC voltage source, apply the black probe to negative terminal, red probe to positive terminal

E. Pointer adjustment
   1. Remove both probes from their jacks and check position of needle
   2. It should point to zero volts--if it does not, turn pointer adjustment screw so that it does--if needle cannot be adjusted, the meter is broken and should be sent to factory for repair

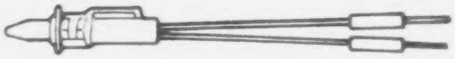
F. Ohms adjustment knob
   1. Each time you turn the selector to an ohms position from another position, you must zero-adjust the ohms scale
   2. Plug test leads into their jacks--hold or clip their probe ends firmly together--turn ADJ knob until needle reads zero ohms--green letter omega (Ω) is the symbol for ohms

G. Test probes
   1. In order to get correct readings on the volt-ohm meter, both probes must make firm electrical contact at the test points
   2. Alligator type probes usually do this best--they also free your hands for manipulating parts during the test
   3. Needle-type probes may be required to get into tight spots or to make contact with very small terminals
   4. You can get alligator probes that slip over needle probes, or use two pairs of test leads--one with alligator probes, the other with needle probes

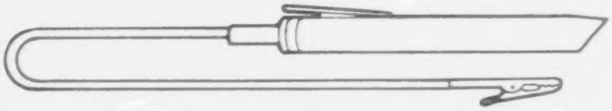
III. The ammeter (TM 2)

IV. Other testing devices

A. Neon tester--determines the presence of voltage between 90 and 550 volts in a circuit



B. Continuity tester--has a self-contained battery to test if a circuit is unbroken--it cannot be used on live circuits or interchanged with the neon tester



V. Care of electrical testing equipment

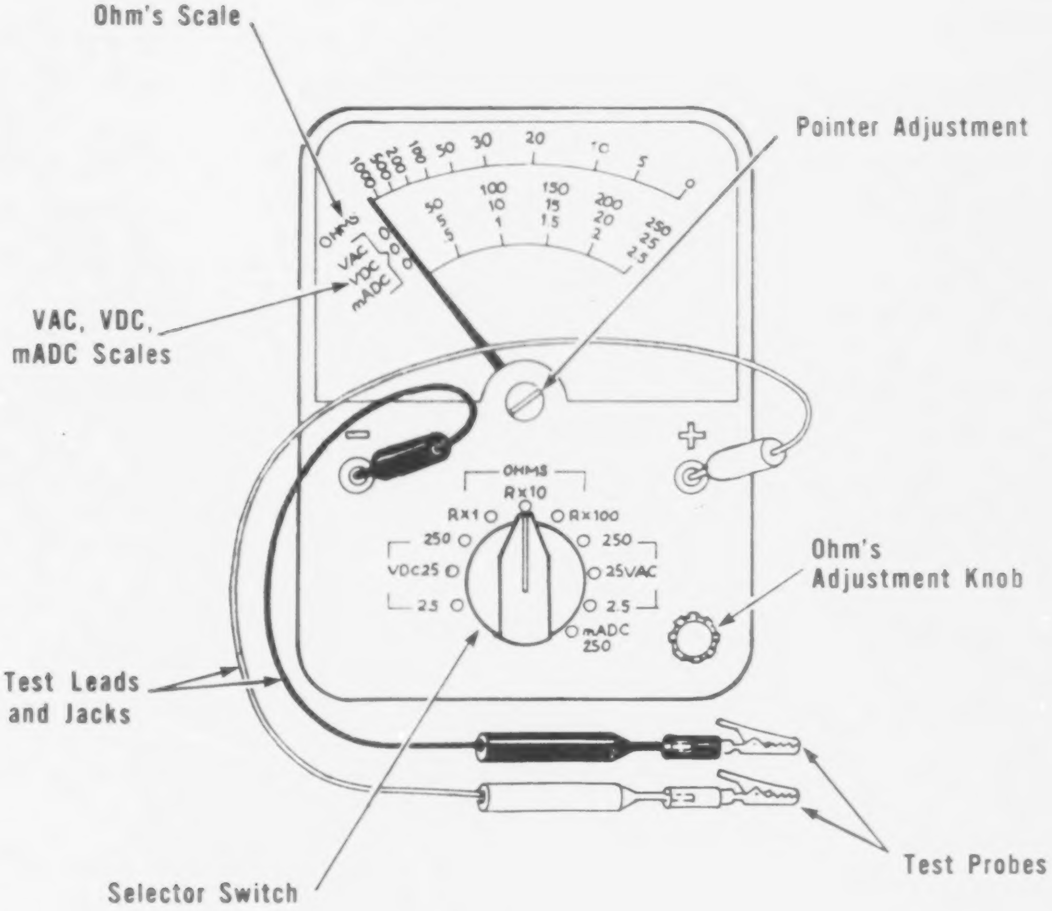
   A. Testing Equipment should be stored in proper cases, and kept clean and dry

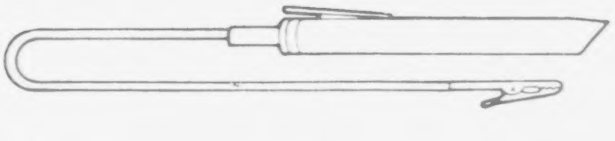
   B. Avoid bumping or jolting as this may damage the internal workings of the instrument

   C. Use instrument only for its intended purpose and only within its range limits

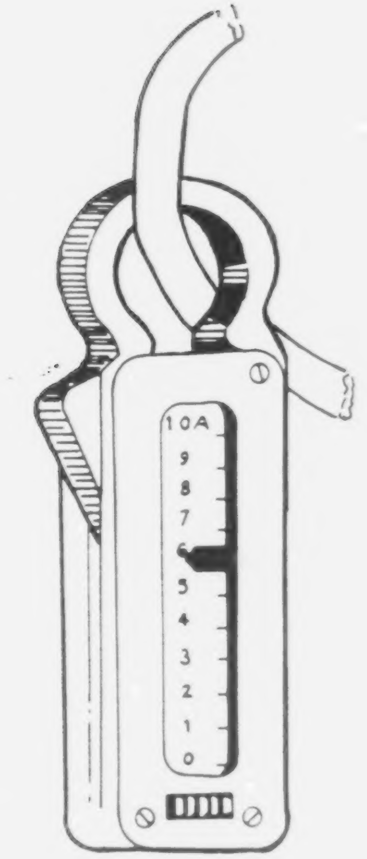
   D. Avoid exposing testing equipment to extreme temperatures

Electrical Testing Equipment


Ohm's Scale
Pointer Adjustment
VAC, VDC, mADC Scales
OHMS
VAC
VDC
mADC
−
+
OHMS
R×10
R×1
R×100
250
VDC 25
2.5
250
25 VAC
2.5
mADC 250
Ohm's Adjustment Knob
Test Leads and Jacks
Selector Switch
Test Probes



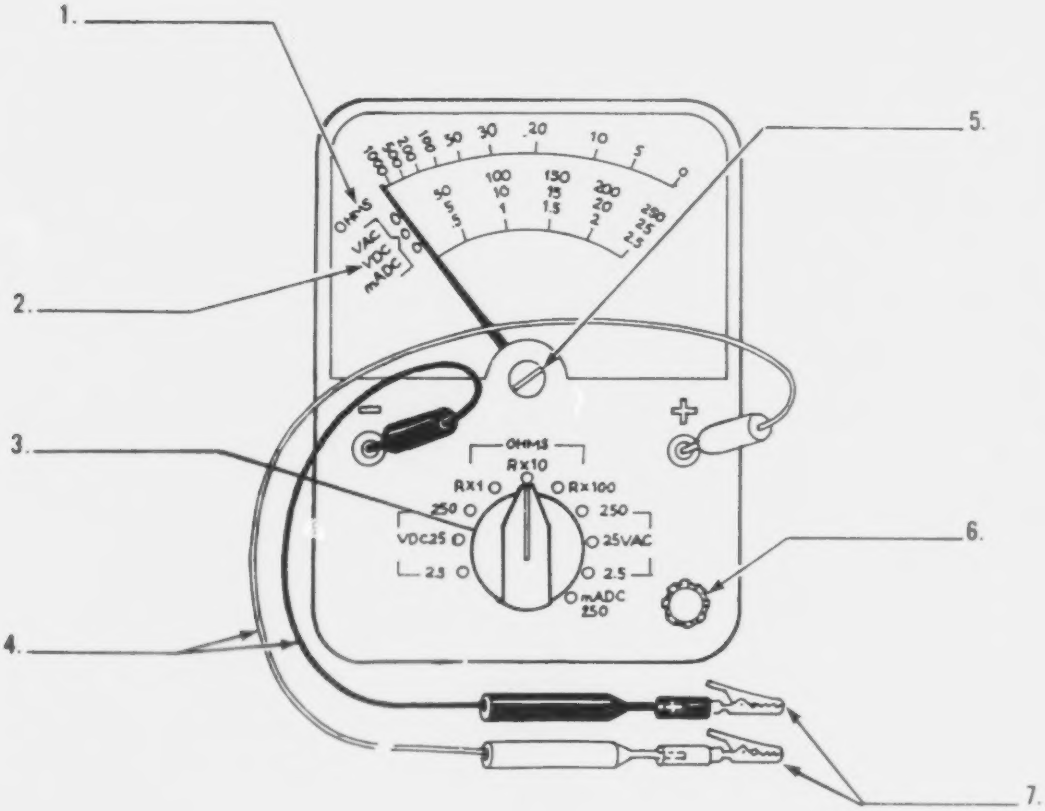
The Ammeter


10A
9
8
7
6
5
4
3
2
1
0

LIST PARTS OF A VOLT-OHM METER

Directions: Using the list below, identify the parts of a volt-ohm meter.

A. VAC, VDC and MADC scales
B. Test leads and jacks
C. Selector switch
D. Test probes
E. Ohms adjustment knob
AB. Pointer adjustment
AC. Ohms scale


1.
2.
3.
4.
5.
6.
7.
OHMS
VAC
VDC
mADC
1000
500
200
100
50
30
20
10
5
0
50
5
.5
100
10
1
150
15
1.5
200
20
2
250
25
2.5
−
+
OHMS
Rx10
Rx1
Rx100
250
VDC25
2.5
250
25VAC
2.5
mADC
250

ANSWERS TO ASSIGNMENT SHEET

Assignment sheet 1

1. AC
2. A
3. C
4. B
5. AB
6. E
7. D

USING THE VOLT-OHM METER TO TEST THE VOLTAGE AT A 125-VOLT WALL OUTLET

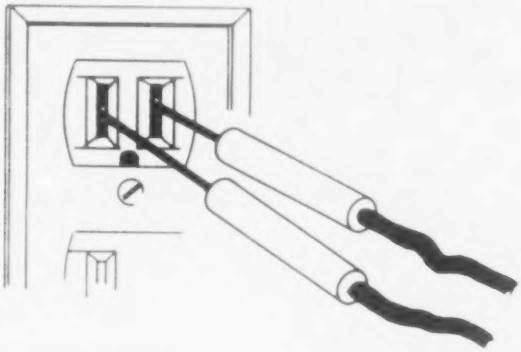
Equipment:

Volt-ohm meter
Safety glasses
125-volt duplex grounded receptacle

Procedure:

	Evaluation 3	 2	 1	 N
1. Cut off power to the outlet by removing fuse or switching off the circuit breaker.	___	___	___	___
2. Set the volt-ohm meter to the 250 VAC scale.	___	___	___	___
3. Insert needle probes into the slots of the wall receptacle.	___	___	___	___
4. Activate the outlet by replacing the fuse or throwing the circuit breaker on.	___	___	___	___
5. Read the volt-ohm meter.	___	___	___	___

(Note: The meter should register between 100-150 VAC.)



6. Have instructor check your work.	___	___	___	___
7. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials.	___	___	___	___
Average of above evaluations*	___	___	___	___

***This average is the student's partial evaluation for competency D-6 of Building Maintenance.**

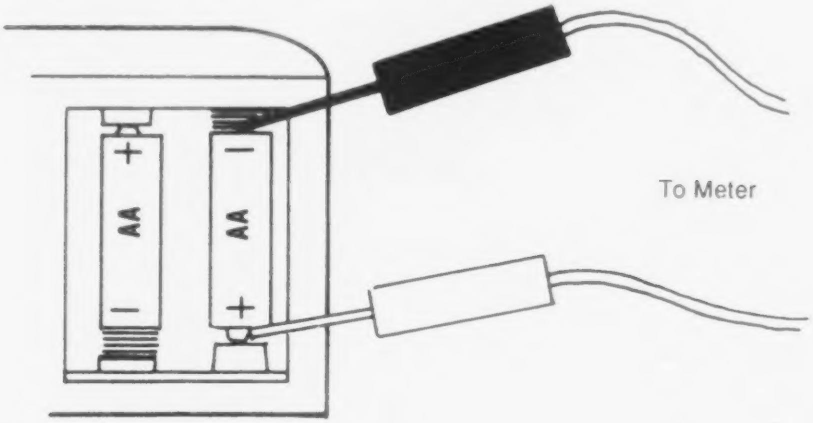
JS 2

USING THE VOLT-OHM METER TO TEST A DRY-CELL BATTERY

Equipment:

Volt-ohm meter
1.5-volt battery from either a calculator or portable radio
Safety glasses

Procedure:	Evaluation 3	2	1	N
1. Set the volt-ohm meter to the 2.5 VDC scale.				
2. Touch the probes to the battery terminals. (Note: red probe to + and black to - .)				
3. Turn the unit on. (Note: The battery must have an electrical load on it.)				
4. The volt-ohm meter should read 1.5. (Note: If it falls below 1.3, the battery is dead.)				



	3	2	1	N
5. Have instructor check your work.				
6. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials.				
Average of above evaluations*				

*This average is the student's partial evaluation for competency D-6 of Building Maintenance.

USING THE AMMETER TO CHECK CURRENT OF AN OPERATING CIRCUIT

Equipment:

Ammeter
Conductor
Safety glasses

Procedure:	Evaluation 3	 2	 1	 N
1. Select highest ammeter scale.	__	__	__	__
(Note: Always begin with highest scale setting because amperage induced above a scale setting may cause damage to the meter.)				
2. Place movable clamp around conductor being tested.	__	__	__	__
3. Read amperage indicated by the pointer on the scale.	__	__	__	__
(Note: If amperage reading is very low (first third portion of scale), change ammeter setting to a lower scale and read again. This should be repeated until a "middle-third reading" is obtained.)				
4. Record reading and compare with amperage rating or requirement.	__	__	__	__
5. Have instructor check your work.	__	__	__	__
6. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials.	__	__	__	__
Average of above evaluations*	__	__	__	__

*This average is the student's partial evaluation for competency D-6 of Building Maintenance.

JS 4

USING THE NEON TESTER TO TEST A 120-VOLT CIRCUIT

Equipment:

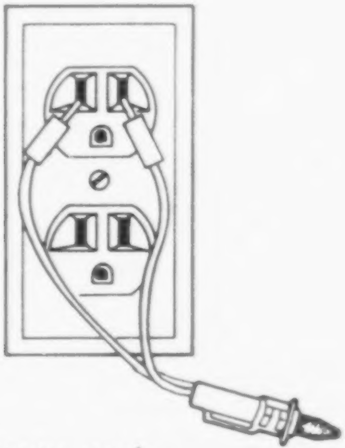
Neon tester
120-volt outlet
Safety glasses

Procedures: Evaluation 3 2 1 N

1. Firmly press each lead of the tester into the receptacle slots to form a good electrical contact. ___ ___ ___ ___

2. If voltage is present, the neon will glow softly. ___ ___ ___ ___

   (Note: This same test may be done with 240-volt circuit. The light will glow more brightly.)



3. Have instructor check your work. ___ ___ ___ ___

4. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations*

*This average is the student's partial evaluation for competency D-6 of Building Maintenance.

USING THE CONTINUITY TESTER TO CHECK A HOUSE FUSE

Equipment:

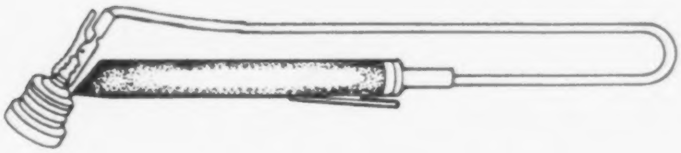
Continuity tester
Fuse
Safety glasses

Procedure: Evaluation
3 2 1 N

1. Remove fuse from box with CAUTION. ___ ___ ___ ___

2. Apply probe of tester to metal bands of fuse. ___ ___ ___ ___

3. Apply alligator clip to center contact. ___ ___ ___ ___



4. Tester will light if fuse is good. It will stay dark if fuse is blown. ___ ___ ___ ___

5. Have instructor check your work. ___ ___ ___ ___

6. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

***This average is the student's partial evaluation for competency D-6 of Building Maintenance.**

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 6: USING ELECTRONIC TEST EQUIPMENT

LESSON TEST

Part 1. Match the terms below to the correct definitions by placing the letter in the blank.

A. Continuity tester
B.
C. Volt-ohm meter
D. Ohm
E. VAC

_____ 1. A unit of measure of electrical resistance

_____ 2. Volts alternating current

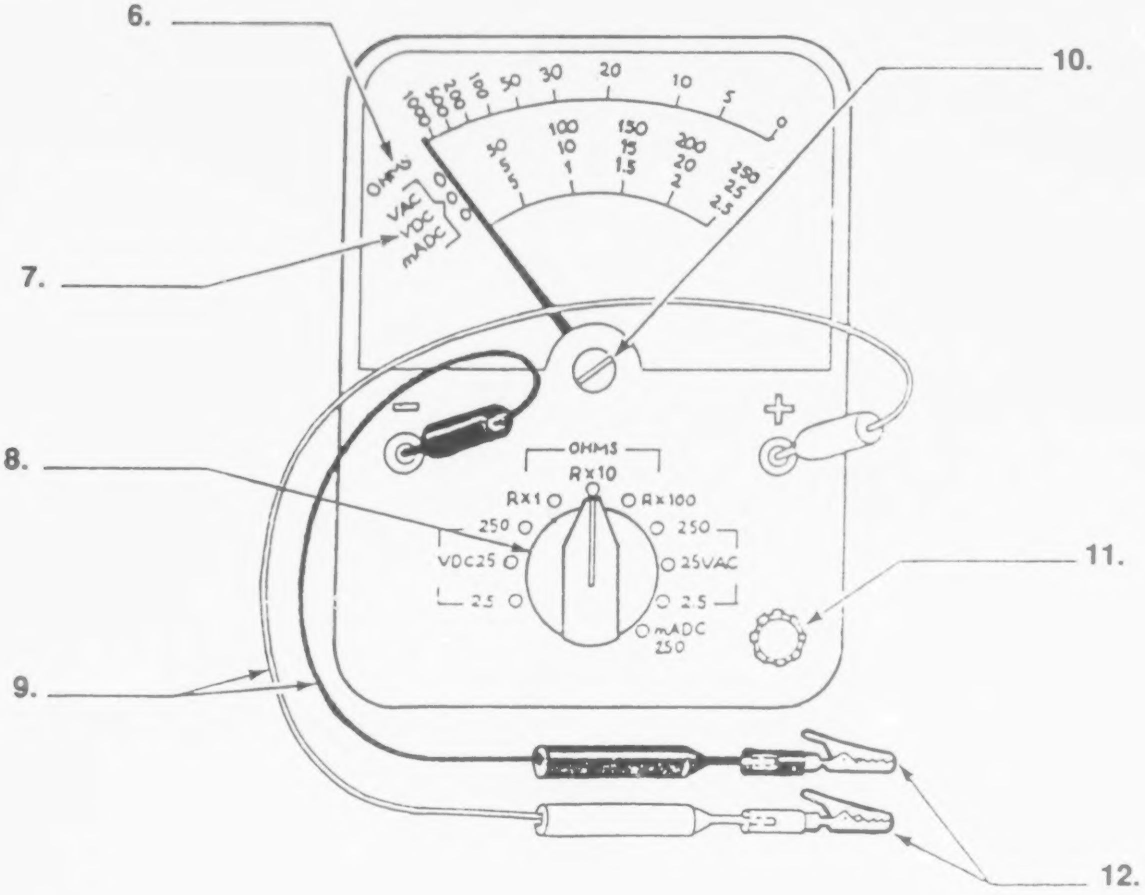
_____ 3. An electrical measuring instrument used to troubleshoot electrical problems

_____ 4. Symbol meaning infinity

_____ 5. Has self-contained battery to test if circuit is unbroken

Part 2. Using the list below, identify the parts of a volt-ohm meter.

A. VAC, VDC and MADC scales
B. Test leads and jacks
C. Selector switch
D. Test probes
E. Ohms adjustment knob
AB. Pointer adjustment
AC. Ohms scale


6.
10.
7.
8.
9.
11.
12.
OHMS
VAC
VDC
mADC
1000
500
200
100
50
30
20
10
5
0
0
0
0
50
5
.5
100
10
1
150
15
1.5
200
20
2
250
25
2.5
−
+
OHMS
Rx10
Rx1
Rx100
250
VDC25
2.5
250
25VAC
2.5
mADC
250

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

ANSWERS TO UNIT I, LESSON 6 TEST

Part 1.

1. D
2. E
3. C
4. B
5. A

Part 2.

6. AC
7. A
8. C
9. B
10. AB
11. E
12. D

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 7: MAKING MINOR REPAIRS AND CHANGING LIGHT BULBS

LESSON OBJECTIVE

After completion of this lesson, the student will be able to SERVICE A FLUORESCENT LIGHT FIXTURE, INSTALL A PIPE-SUPPORTED LIGHT FIXTURE, REPLACE APPLIANCE AND EXTENSION CORD PLUGS, DEMONSTRATE THE PROPER PROCEDURE FOR ELECTRICAL SOLDERING AND CHANGING LIGHT BULBS. Mastery will be evidenced by satisfactory completion of assignment sheets, job sheets and by scoring ____________ percent on the lesson test.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Match the terms associated with minor electrical repairs to the correct definitions.
2. Identify the parts of a fluorescent light fixture.
3. Identify the parts of a pipe-supported light fixture.
4. Demonstrate the ability to troubleshoot a fluorescent lamp.
5. Change a fluorescent lamp bulb.
6. Install a starter in a fluorescent lamp.
7. Install a pipe-supported light fixture.
8. Replace extension and appliance cord plugs.
9. Solder electrical wire.
10. Replace light bulbs.

Completion of the requirements of this lesson fulfills competency D-7 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 7: MAKING MINOR REPAIRS AND CHANGING LIGHT BULBS

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
  1. Fluorescent lamp fixture
  2. Multiple-socket, pipe-supported lamp fixture
  3. Fixture installation techniques
  4. Fixture installation techniques
  5. Fixture installation techniques
  6. Common lighting fixtures
  7. Replacing plug ends
  8. Rewiring a two-prong plug
  9. Rewiring a three-prong plug

D. Assignment sheets
  1. Identify parts of a fluorescent lamp fixture
  2. Basic soldering procedures

E. Answers to assignment sheets

F. Job sheets
  1. Replacing a fluorescent lamp
  2. Install starter in a fluorescent lamp
  3. Install pipe-supported light fixture
  4. Replace extension and appliance cord plugs
  5. Solder electrical connections
  6. Replace incandescent bulb

G. Lesson test

H. Answers to lesson test

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

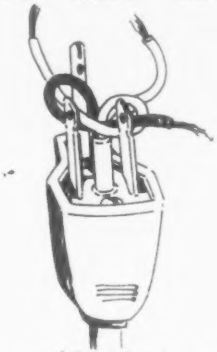
UNIT I: ELECTRICAL PROCEDURES

LESSON 7: MAKING MINOR REPAIRS AND CHANGING LIGHT BULBS

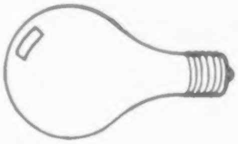
INFORMATION OUTLINE

I. Terms and definitions

- A. Rosin core solder--solder used in electrical work rosin flux core.
- B. Underwriter's knot--knot used in electrical wiring procedures



- C. Ballast--magnetic coil that adjusts the current through fluorescent bulbs
- D. Starter--automatic switch on fluorescent fixtures
- E. Incandescent lamp--electric light bulb in which a filament is heated to give off light by an electric current



- F. Fluorescent lamp--a bulb that consists of a glass tube with its inner wall coated with a material that glows when showered by a gas discharge inside the tube

II. Parts of a fluorescent lamp fixture (TM 1)

A. Bulb

B. Ballast

C. Starter

D. Holder

E. Starter socket

III. Troubleshooting fluorescent lamps

Problem	Causes	Repairs
Lamp won't light	1. Burned-out bulb	1. Replace bulb
	2. Defective starter	2. Replace starter
	3. Defective ballast, sometimes accompanied by the odor of burning insulation	3. Consider cost of new ballast in comparison to value of lamp fixture before replacing ballast
	4. Defective switch	4. Replace switch
	5. Lamp not seated correctly in socket	5. Reseat lamp in socket
	6. No power to lamp	6. Check power circuit
Lamp glows dimly	1. Defective bulb	1. Replace bulb
	2. Defective starter	2. Replace starter
Lamp ends are lighted	1. Incorrect wiring	1. Check wiring
	2. Starter is shorted	2. Replace starter
	3. Bulb is burned out	3. Replace bulb
Spiraling or flickering lamp	1. Bulb is burned out	1. Replace bulb
	2. Defect or wrong type starter	2. Replace starter with one of correct voltage
	3. Low line voltage	3. Check voltage within 10% of 120 volts
	4. Wrong ballast	4. Replace ballast
Lamp flashes ON and OFF repeatedly	1. Defective bulb	1. Replace bulb
	2. Defective starter	2. Replace starter

IV. Parts of a regular incandescent lamp fixture (TM 2, TM 3, TM 4, TM 5)

   A. Fixture strap

   B. Strap mounting screw

   C. Threaded pipe

   D. Fixture

   E. Socket

   F. Locknuts

V. Common fixtures (TM 6)

   A. Ceiling fixture

   B. Fluorescent lighting fixture

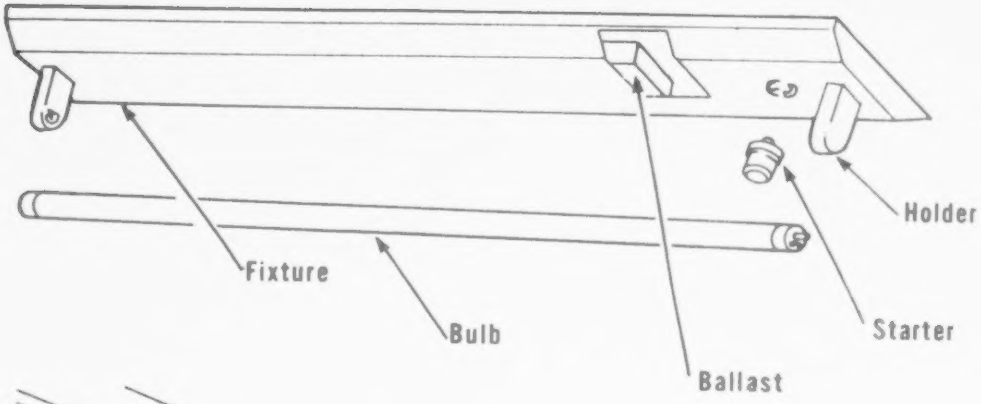
   C. Recessed lighting fixture

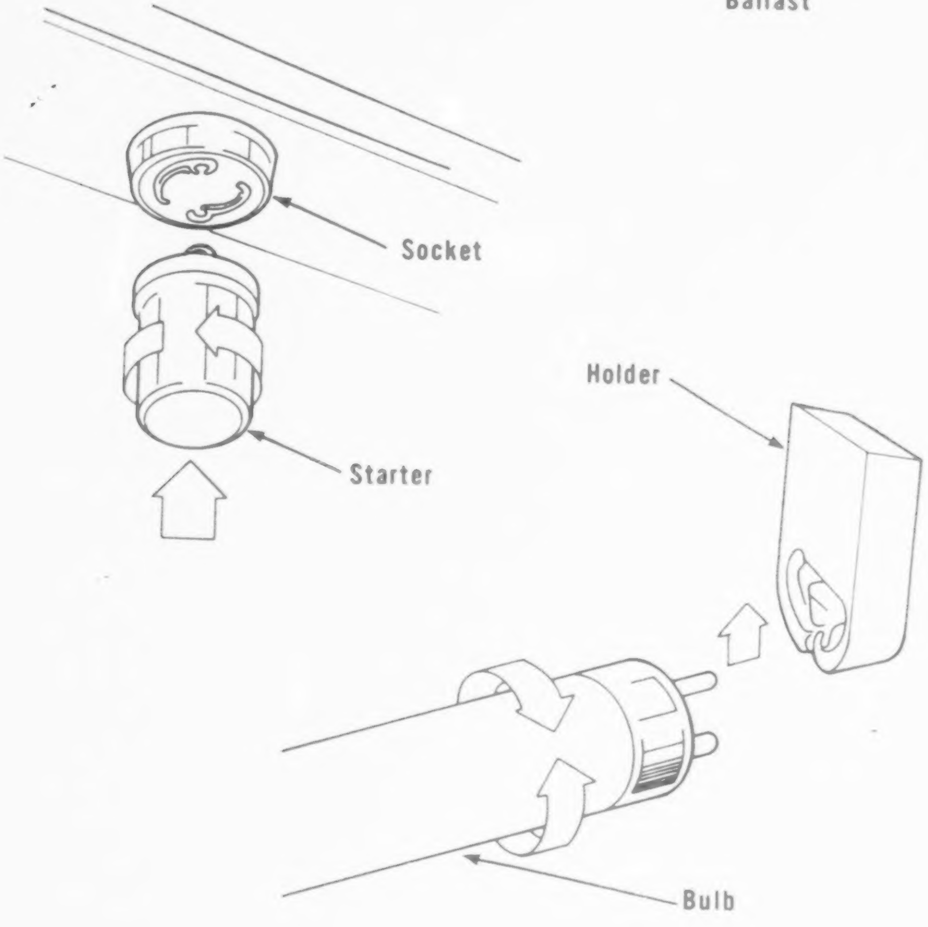
   D. Chandeliers

   E. Outdoor light fixtures

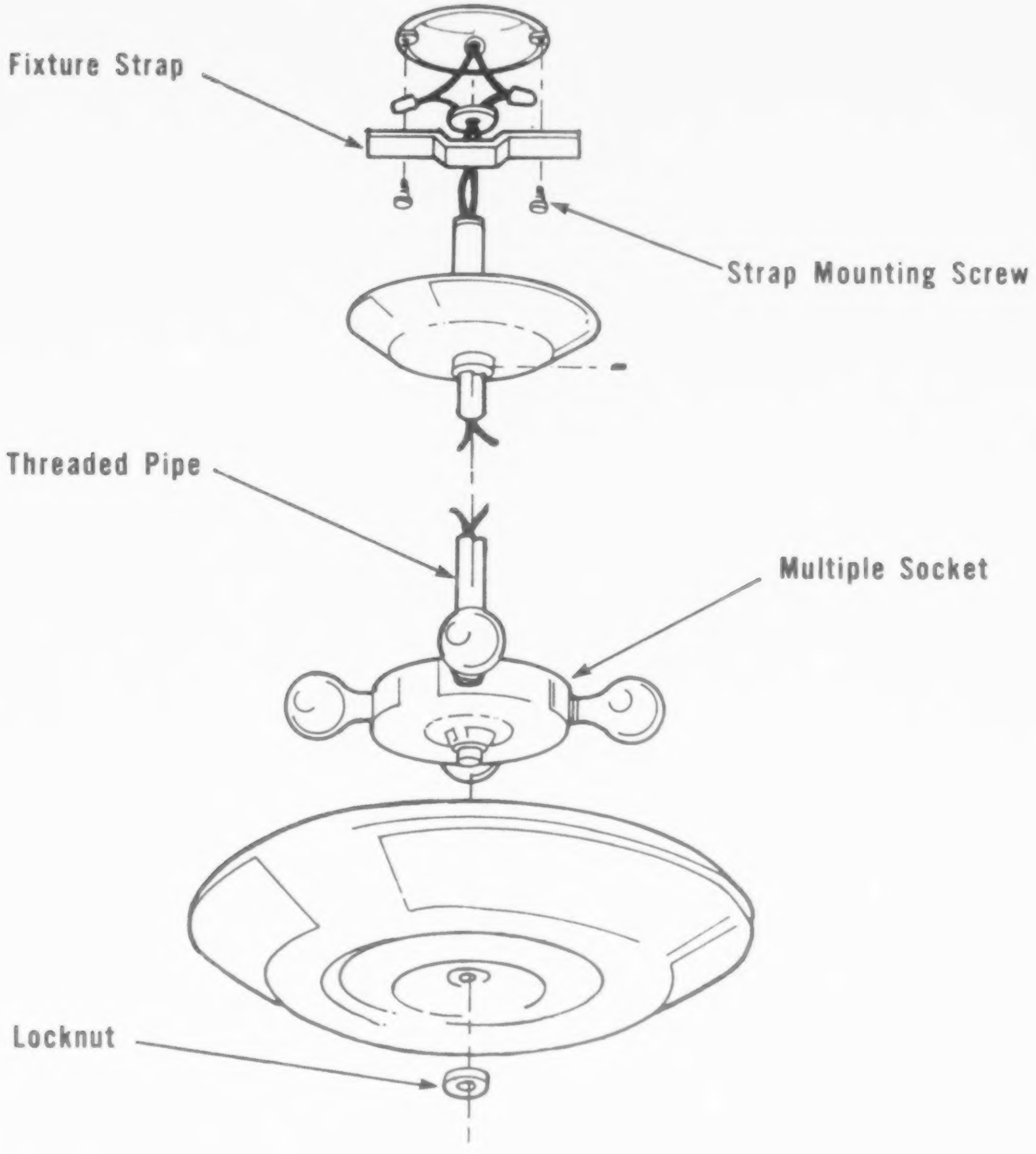
TM 1

Flourescent Lamp Fixture


Holder
Fixture
Bulb
Starter
Ballast

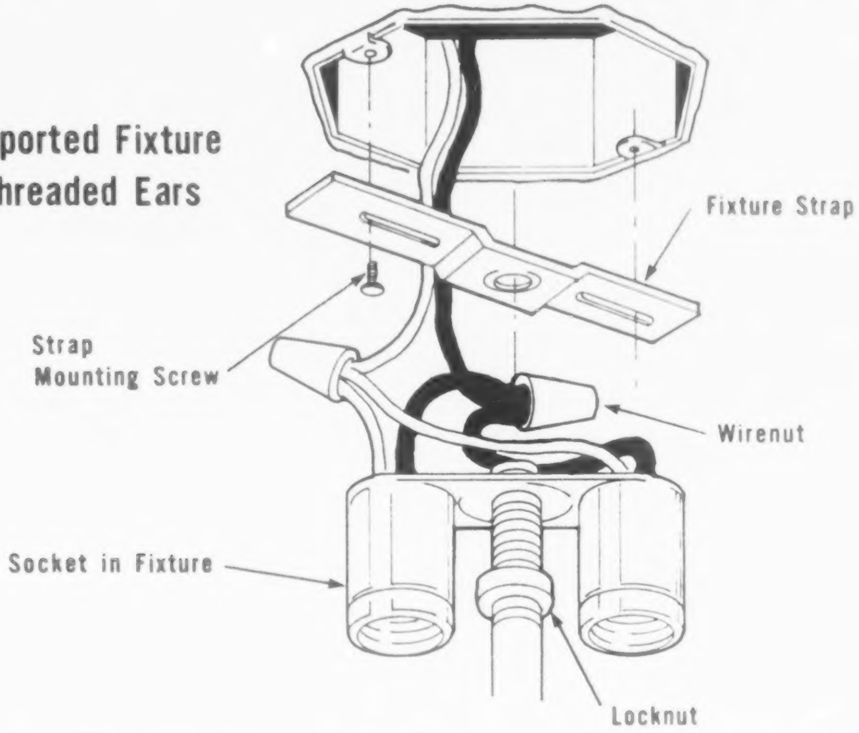

Socket
Starter
Holder
Bulb

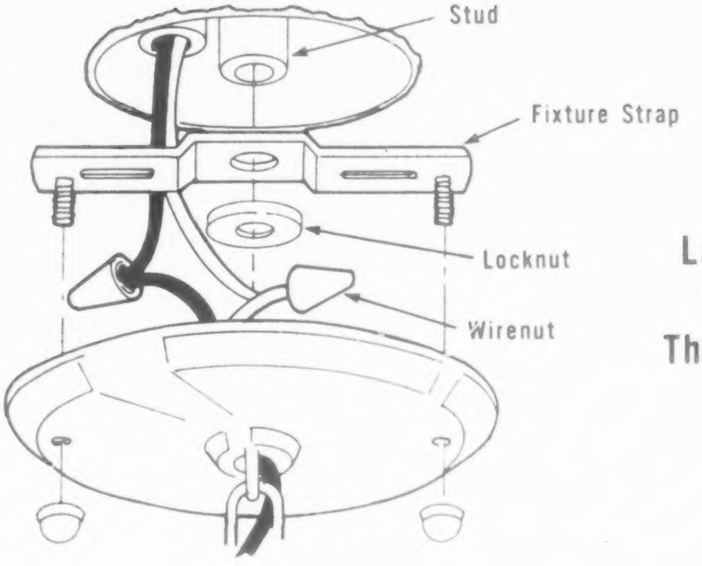
Multiple-Socket, Pipe-Supported Lamp Fixture


Fixture Strap
Strap Mounting Screw
Threaded Pipe
Multiple Socket
Locknut

Fixture Installation Techniques

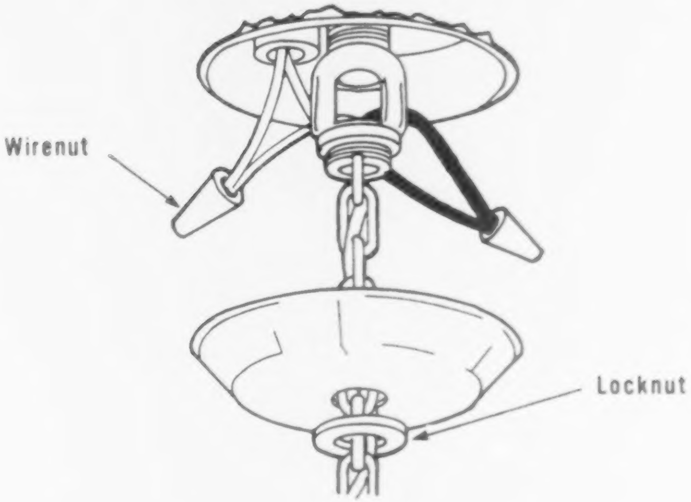
Pipe-Supported Fixture With Threaded Ears

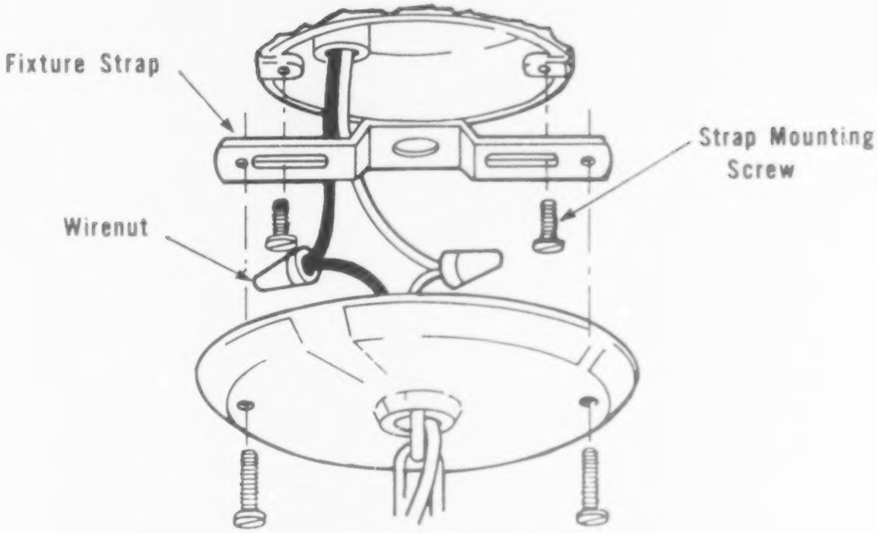

Fixture Strap
Strap Mounting Screw
Wirenut
Socket in Fixture
Locknut


Stud
Fixture Strap
Locknut
Wirenut

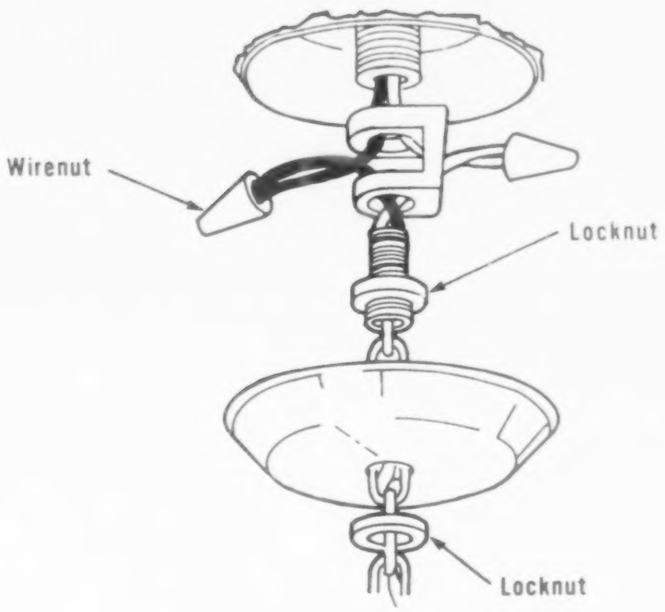
Lamp Fixture With no Threaded Ears

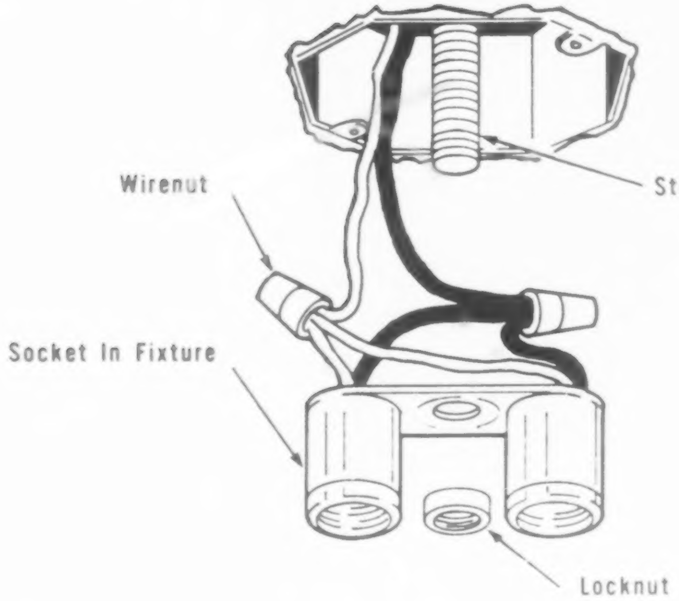
Fixture Installation Techniques


Wirenut
Locknut

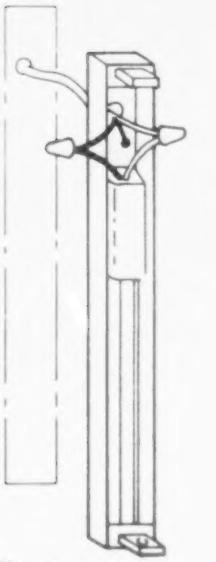

Fixture Strap
Strap Mounting Screw
Wirenut

Fixture Installation Techniques

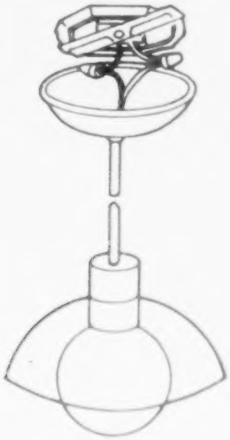

Wirenut
Locknut
Locknut


Wirenut
Stud
Socket In Fixture
Locknut

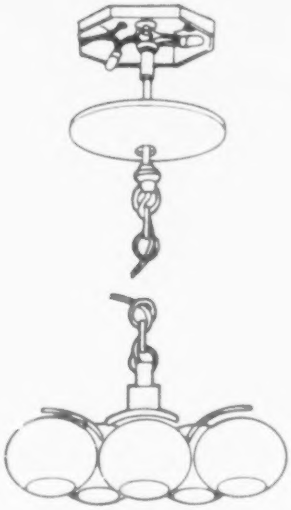
Common Lighting Fixtures



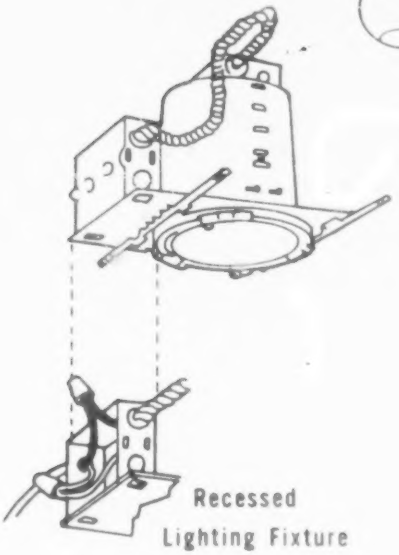
Flourescent Light Fixture



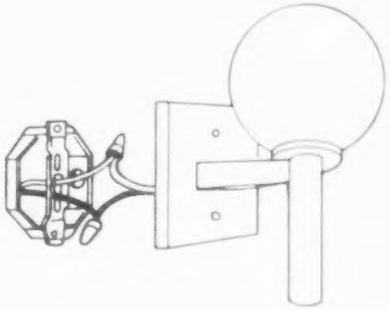
Ceiling Fixture



Chandeliers

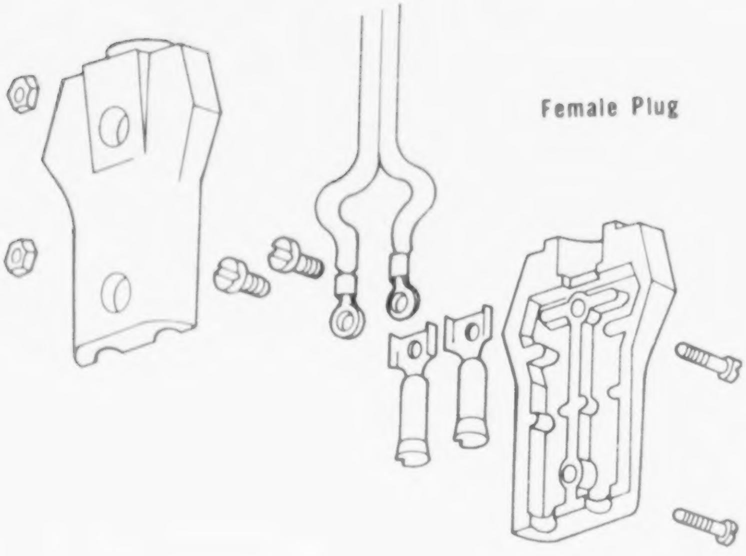


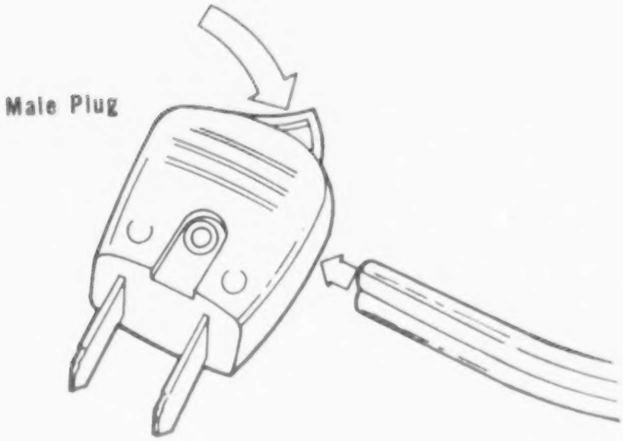
Recessed Lighting Fixture



Outdoor Light Fixture

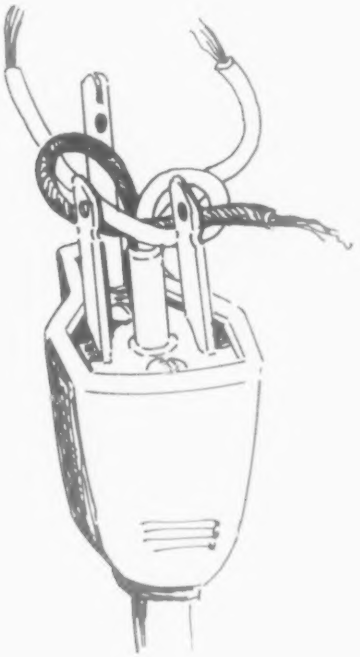
Replacing Plug Ends

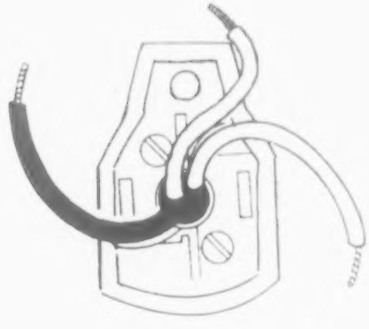

Female Plug

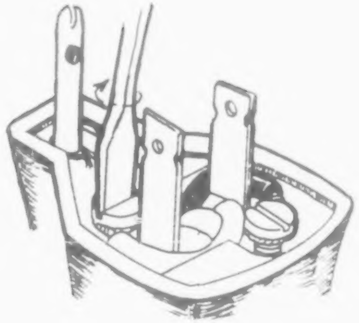


TM 8

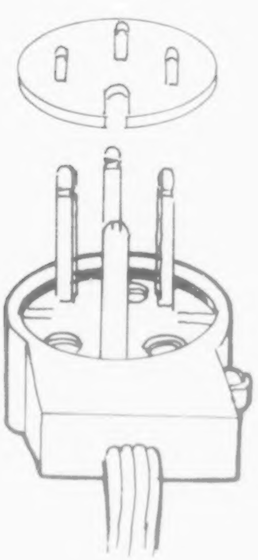
Rewiring a Two-Prong Plug

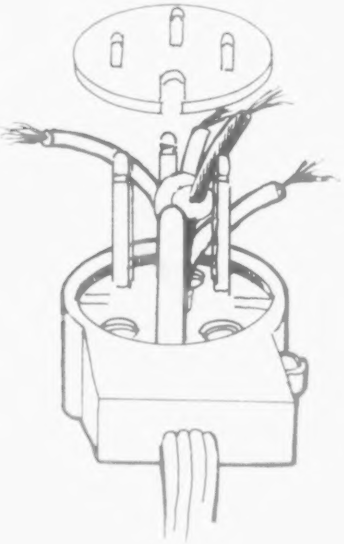


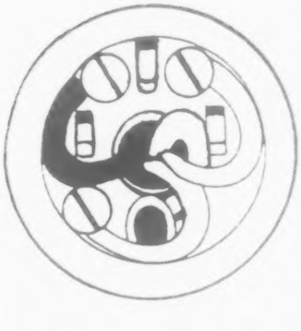


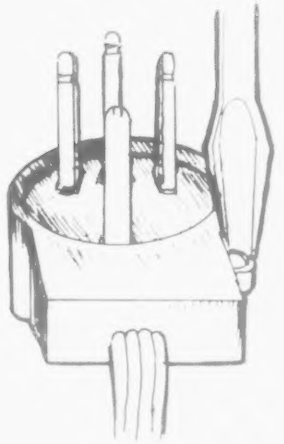


Rewiring a Three-Prong Plug





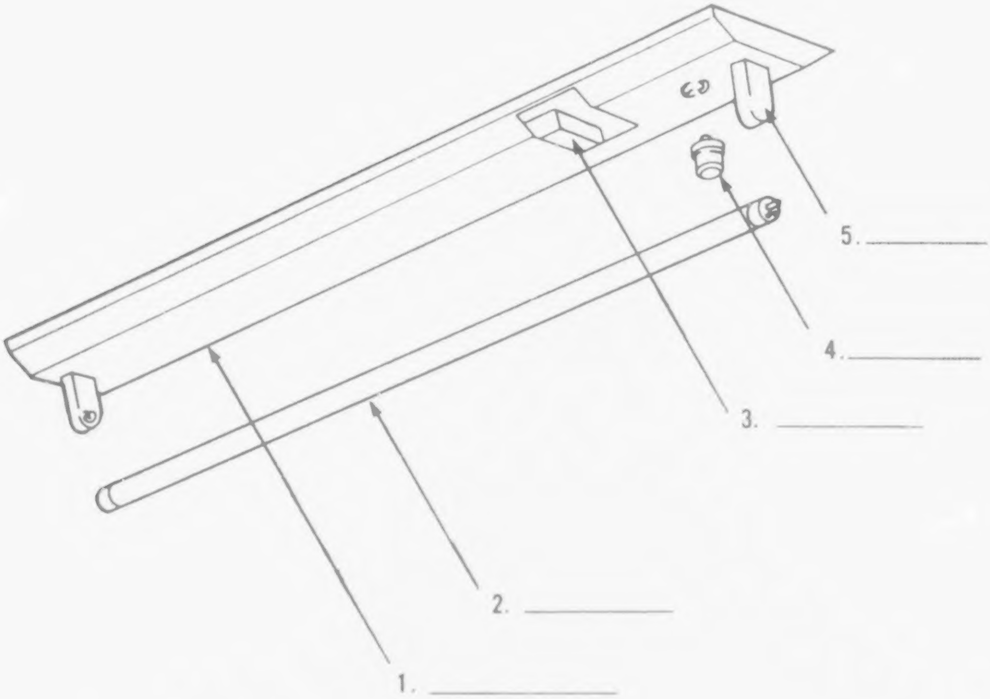




IDENTIFY PARTS OF A FLUORESCENT LAMP FIXTURES

Instructions: Using the list of terms below, select the correct name of each part of a florescent lamp fixture and write its letter in the correct blank.

A.	Starter	D.	Bulb
B.	Holder	E.	Ballast
C.	Fixture		

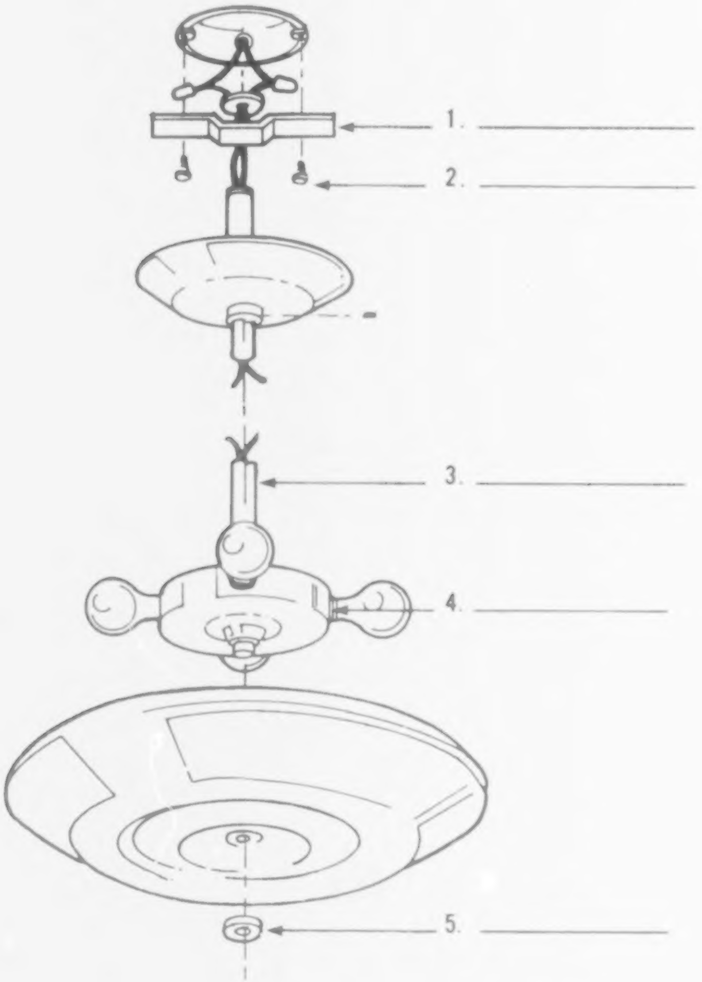


AS 2

IDENTIFY PARTS OF A PIPE-SUPPORTED LAMP FIXTURE

Instructions: Using the list of parts given below, select the correct name of each part of a pipe-supported lamp fixture and write its letter in the correct blank.

A. Locknut
B. Multiple socket
C. Fixture strap
D. Strap mounting screw
E. Threaded pipe



ANSWERS TO ASSIGNMENT SHEETS 1 - 2

Assignment sheet 1

1. C 2. D 3. E 4. A

5. B

Assignment sheet 2

1. C 2. D 3. E 4. B

5. A

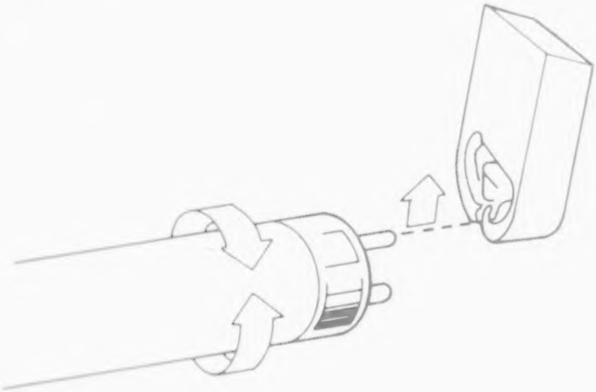
REPLACING A FLUORESCENT LAMP

Equipment:

Ladder
Safety glasses
Gloves
New fluorescent bulb

Procedure:

	Evaluation 3 2 1 N
(CAUTION: instructor MUST be present.)	
1. Put on safety glasses and gloves.	___ ___ ___ ___
2. Turn OFF power to fixture.	___ ___ ___ ___
3. Carefully twist and remove the old bulb to the ground.	___ ___ ___ ___
4. Insert the prongs of the new bulb into the holder one end at a time.	___ ___ ___ ___



5. Make sure bulb is held firmly by both end holders before releasing.	___ ___ ___ ___
6. Turn on power.	___ ___ ___ ___
7. Have instructor check your work.	___ ___ ___ ___

8. Discard old bulbs carefully. They are extremely dangerous and are very likely to explode with very little contact. Do not put old bulbs outside. Destroy them safely inside. ___ ___ ___ ___

9. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

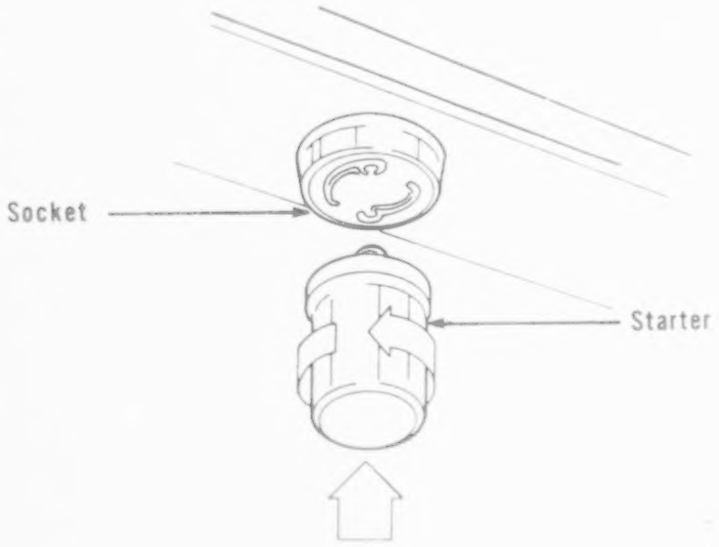
*This average is the student's partial evaluation for competency D-7 of Building Maintenance.

INSTALL A STARTER IN A FLUORESCENT LAMP

Equipment:

Ladder
Safety glasses
Gloves
New starter

Procedure:	Evaluation 3	 2	 1	 N
(CAUTION: Instructor MUST be present.)				
1. Put on safety glasses and gloves.	___	___	___	___
2. Turn OFF power to fixture.	___	___	___	___
3. Carefully remove bulb.	___	___	___	___
4. Remove old starter by rotating slightly and pulling gently downward.	___	___	___	___
5. Install new starter by simply inserting and twisting it slightly to secure it in its socket.	___	___	___	___



6. Replace bulb. ___ ___ ___ ___
7. Turn on power. ___ ___ ___ ___
8. Have instructor check your work. ___ ___ ___ ___
9. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations*

---

*This average is the student's partial evaluation for competency D-7 of Building Maintenance.

INSTALL A PIPE-SUPPORTED LIGHT FIXTURE

Equipment:

Screwdriver
Electrician's diagonal cutters
Wire strippers
Pliers
Stepladder
Replacement lamp fixture
Solderless connectors
Safety glasses

Procedure: Evaluation
3 2 1 N

(CAUTION: Instructor MUST be present.)

1. Turn power OFF to fixture. ___ ___ ___ ___
2. Put on safety goggles. ___ ___ ___ ___
3. Carefully remove old locknut on old fixture. ___ ___ ___ ___
4. Remove old fixture. ___ ___ ___ ___
5. Remove solderless connectors. ___ ___ ___ ___
6. Separate the wires connecting fixture. Before joining new wires of fixture to old circuit wires, you may have to strip old wires. ___ ___ ___ ___
7. Use the diagonal cutters and wire strippers to prepare old circuit wires. ___ ___ ___ ___
8. Connect the fixture wires to circuit wires by using solderless connectors. ___ ___ ___ ___
9. Hold fixture body up to its final mounting position on threaded pipe. ___ ___ ___ ___
10. Screw threaded pipe into fixture strap far enough so that it holds fixture firmly in place. ___ ___ ___ ___
11. Screw bulb in the socket. ___ ___ ___ ___

12. Place the outer globe fixture in place. ___ ___ ___ ___

13. Place the outer locknut in position. Be sure to adjust the position of the locknut to keep fixture secure against the ceiling. ___ ___ ___ ___

14. Turn on the power and check to see if fixture will light. ___ ___ ___ ___

15. Have instructor check your work. ___ ___ ___ ___

16. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

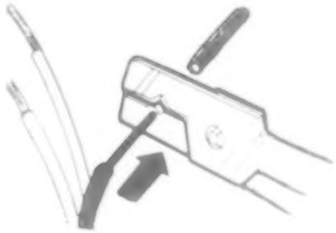
*This average is the student's partial evaluation for competency D-7 of Building Maintenance.

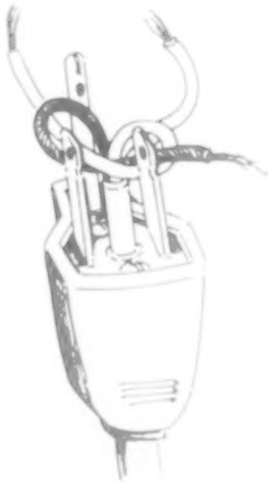
REPLACE EXTENSION AND APPLIANCE PLUGS

Equipment:

Screwdriver
Electrician's diagonal cutters
Wire strippers
Replacement plugs

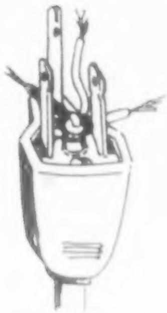
Procedure:	Evaluation 3 2 1 N
(CAUTION: Instructor MUST be present.)	
1. Refer to TM 7 (Replacing plugs).	___ ___ ___ ___
2. Use cutters to remove old plug.	___ ___ ___ ___
3. Use wire strippers to remove outer insulation.	___ ___ ___ ___
4. Separate wires.	___ ___ ___ ___
5. Use wire strippers to remove 1/2 inch of the insulation from wires.	___ ___ ___ ___



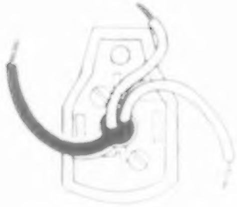


6. Tie underwriter's knot as shown. ___ ___ ___ ___

7. Tighten knot and pull it into plug recess.

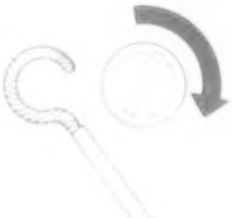


8. Loop each wire around a prong before tightening the bare end under the screw head. This helps keep the wires from touching each other accidentally.

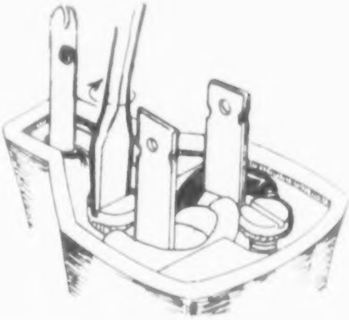


9. Twist strands together if necessary.

10. Loop the end of the wire in a clockwise direction so that the terminal screw sill pull the wire tight under the screw head when it is tightened.



11. Tighten screws firmly. The direction of the loops should follow screw direction as they are tightened. ____ ____ ____



12. Check by turning on the power. ____ ____ ____ ____

13. Have instructor check your work. ____ ____ ____ ____

14. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ____ ____ ____ ____

Average of above evaluations* ____ ____ ____ ____

---

*This average is the student's partial evaluation for competency D-7 of Building Maintenance.

SOLDERING ELECTRICAL CONNECTIONS

Equipment:

Soldering gun
Lineman's pliers
Wire strippers
Safety glasses
Rosin core solder
(Note: Rosin core or solder and flux are acceptable.)
Two 6-inch pieces of copper conductor.

Procedure:

Evaluation
3 2 1 N

(CAUTION: Instructor MUST be present.)

1. Put on safety glasses. ___ ___ ___ ___

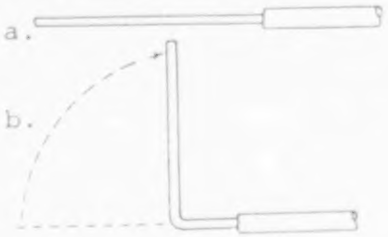
2. Strip approximately 1 inch of insulation from the conductor. ___ ___ ___ ___

3. Form a splice. ___ ___ ___ ___

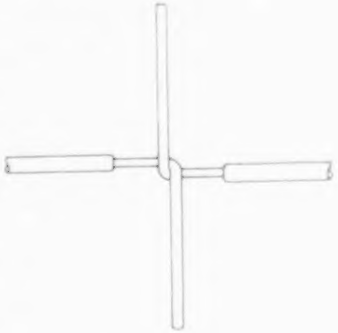
(Note: Any solid splice will work. Two types are illustrated here.

Straight Splice

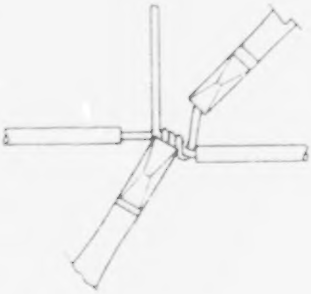
a. Bend 90° angles in both conductors.



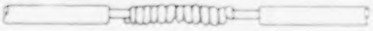
b. Hook conductors together.



c. Hold one conductor secure while wrapping the other.

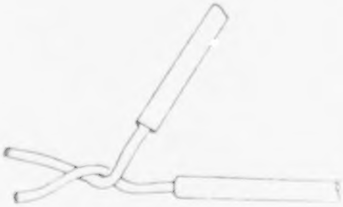


d. Finish straight splice.

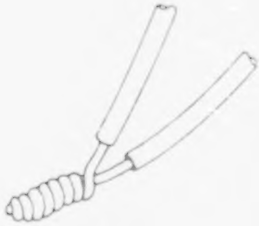


Twist Splice (Pig Tail)

a. Lap conductors over each other.



b. Twist lightly

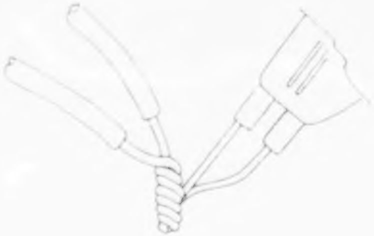


4. Clean tip of soldering gun. — — — —

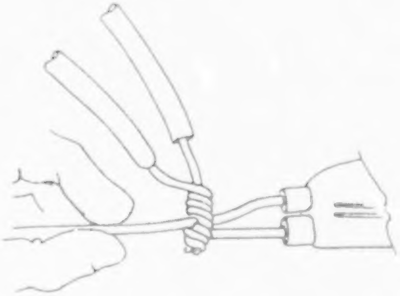
5. Heat gun tip. — — — —

(Note: You can touch the solder to the gun tip to determine if it is hot enough.)

6. Put gun tip on underside of splice to heat it. — — — —



7. Apply solder to top of joint. — — — —



8. Remove soldering gun and solder stick from joint when it has filled. — — — —

9. Have instructor inspect the splice. — — — —

10. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. — — — —

Average of above evaluations* — — — —

***This average is the student's partial evaluation for competency D-7 of Building Maintenance.**

REPLACE INCANDESCENT BULB

Equipment:

Safety glasses
New incandescent bulb
Ladder (if other than table lamp fixture)
Chain-nose pliers

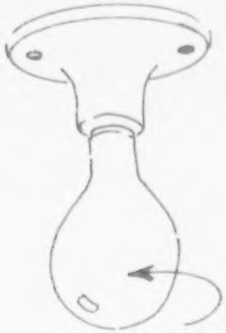
Procedure:

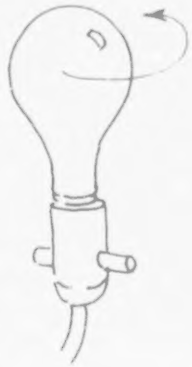
Evaluation
3 2 1 N

1. Turn off power/disconnect fixture. ___ ___ ___ ___

2. Put on safety glasses. ___ ___ ___

3. Remove bulb, being careful not to break the old bulb. ___ ___ ___ ___





(Note: If bulb is broken, make sure all power connections to the circuit are disconnected. Then use chain-nose pliers to remove bulb base from fixture. If fixture is worn or corroded, preventing removal/installation of bulb, replace fixture. DO NOT ATTEMPT TO REPAIR FIXTURE.)

4. Place new bulb in fixture, turning clockwise until firmly in place. (Do not overtighten.) ___ ___ ___

5. Reconnect/restore power and check fixture for proper operation. ___ ___ ___ ___

6. Discard old bulb in a safe waste container. ___ ___ ___ ___

7. Have instructor check your work. ___ ___ ___ ___

8. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluation* ___ ___ ___ ___

*This average is the student's partial evaluation for competency D-7 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT I: ELECTRICAL PROCEDURES

LESSON 7: MAKING MINOR REPAIRS AND CHANGING LIGHT BULBS

LESSON TEST

Part 1. Match the terms below to the correct definitions by placing the correct letter on each blank.

A. Fluorescent lamp

B. Ballast

C. Rosin core solder

D. Starter

E. Underwriter's knot

AB. Incandescent lamp

______ 1. Magnetic coil that adjusts current through fluorescent bulbs

______ 2. Automatic switch on fluorescent fixtures

______ 3. Knot used in electrical wiring procedures

______ 4. Solder used in electrical work and has a rosin flux core

______ 5. Lamp in which a filament is heated

______ 6. Tube that glows from a gas discharge

Part 2. Label five parts of a fluorescent lamp fixture using the list below.

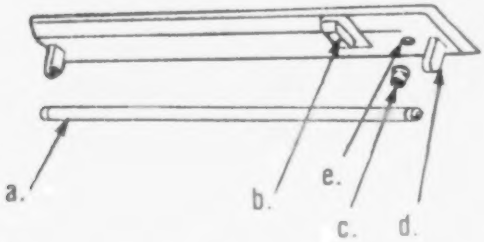
A. Starter socket

B. Holder

C. Ballast

D. Bulb

E. Starter



______ 7. (A)

______ 8. (B)

______ 9. (C)

______10. (D)

______11. (E)

Part 3. Label six parts of an incandescent lamp fixture using the list below.

A. Threaded pipe

B. Fixture

C. Socket

D. Locknuts

E. Fixture strap

AB. Strap mounting screw

______12. (A)

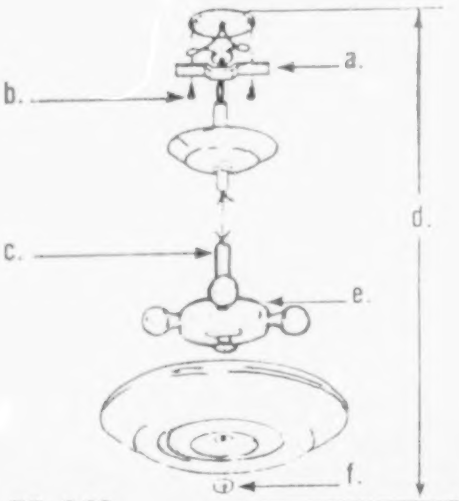
______13. (B)

______14. (C)

______15. (D)

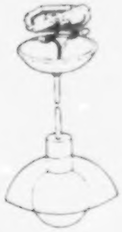
______16. (E)

______17. (F)

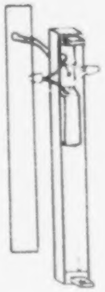


Part 4. Label five common light fixtures using the list below.

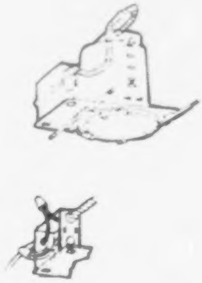
A. Recessed light
B. Fluorescent light
C. Ceiling fixture
D. Outdoor light fixture
E. Chandeliers



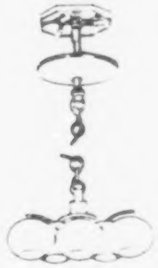
______18.



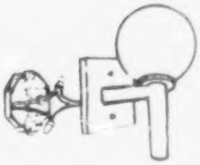
______19.



______20.



______21.



______22.

Part 5. List six reasons why a fluorescent lamp will not light.

23.

24.

25.

26.

27.

28.

Part 6. List two reasons why a fluorescent lamp flashes on and off repeatedly.

1.

2.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

ANSWERS TO UNIT I, LESSON 7 TEST

Part 1.

1. B
2. D
3. E
4. C
5. AB
6. A

Part 2.

7. D
8. C
9. E
10. D
11. A

Part 3.

12. E
13. AB
14. A
15. B
16. C
17. D

Part 4.

18. C
19. B
20. A
21. E
22. D

Part 5.

Burned out bulb
Defective ballast
No power to lamp
Defective starter
Defective switch
Lamp not seated correctly

Part 6.

Defective bulb
Defective starter

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 1: ADJUST/REPLACE BELTS

LESSON OBJECTIVE

After completion of this lesson, the student will be able to RECOGNIZE CONDITIONS REQUIRING BELT REPLACEMENT and REMOVE/REPLACE and PROPERLY ALIGN/ADJUST BELTS. Mastery will be evidenced by completion of job sheets.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Identify safe belt servicing practices.
2. Remove belts.
3. Size belts.
4. Replace belts.

Completion of the requirements of this lesson fulfills competency G-2 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 1: ADJUST/REPLACE BELTS

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
   1. Belt, Pinch Points and Cover
   2. Belt Cross Sections
   3. Belt Adjusting and Aligning Tool

D. Job sheet
   1. Adjust/replace belts

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 1: ADJUST/REPLACE BELTS

INFORMATION OUTLINE

I. General information (TM 1, TM 2, TM 3)

   A. The V-belt is the most popular way to drive environmental control devices--belts are made in layers of rubber, fabric and cord

   B. Pinch points (the point at which the belt approaches the pulley) should be covered with guards

   C. All drive motors should be disconnected to prevent accidental start up while belt guards are removed

   D. Inspect belt for checks, cracks, splits, frays and irregular width or thickness--replace if any of these conditions exist

   E. To remove belts, loosen equipment mounting bolts to allow the motor and the driven unit to move closer together

   F. Belts are sized by the outside length (the distance around the outside of the belt) and by width--special belts must have exact replacements

   G. After placing new belt on the pulleys, apply tension by moving the motor and the driven unit apart and snugging the mounting bolts--motor shaft and the driven unit shaft must now be adjusted to be parallel and the mounting bolts tightened

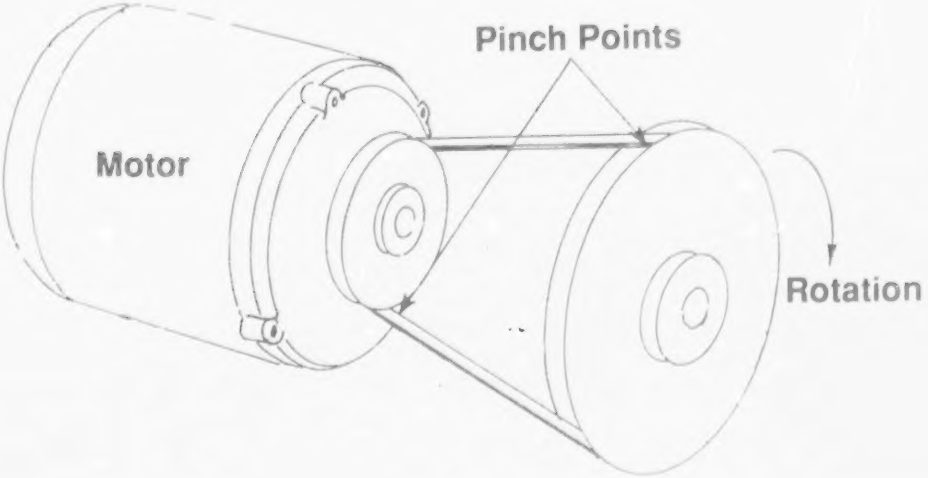
   H. A properly tensioned belt may be depressed approximately one-half inch with a 10-pound force between pulleys

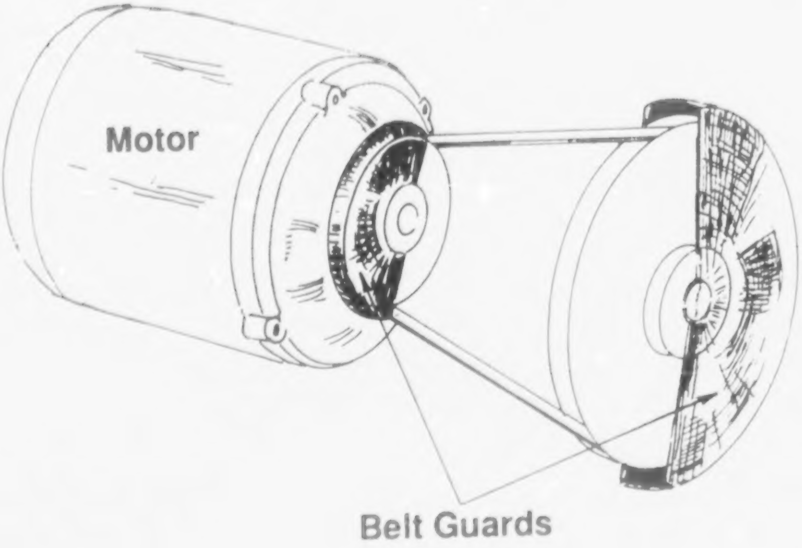
   I. A poorly aligned belt will shorten the life of the drive motor as well as cause noisy and inefficient operation

   J. Some units have self-tensioning features allowing belt removal and replacement without loosening the mounting bolts

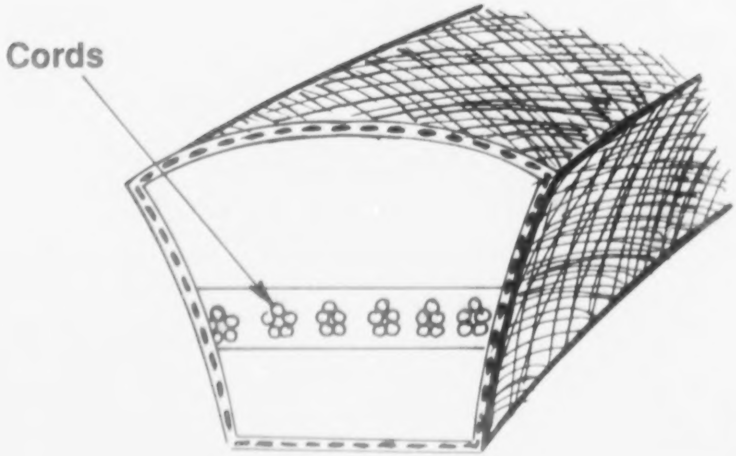
TM 1

Belt, Pinch Points and Cover


Pinch Points
Motor
Rotation

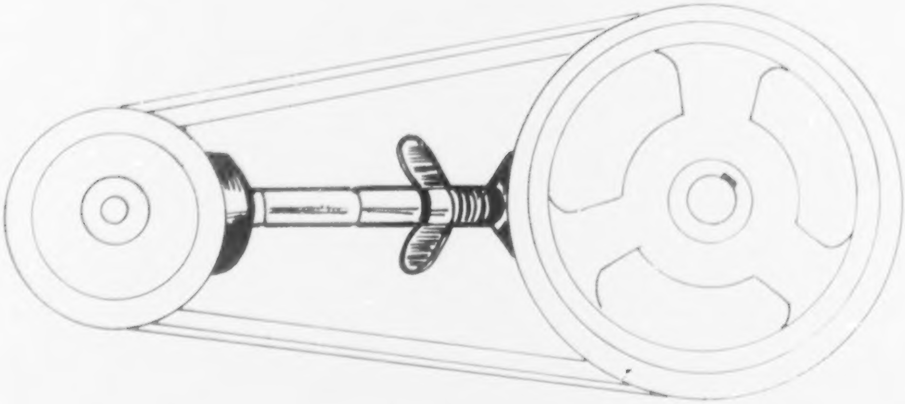

Motor
Belt Guards

Belt Cross Sections



TM 3

Belt Adjusting and Aligning Tool



ADJUST/REPLACE BELTS

Equipment:

Safety glasses
Adjusting wrench
Pry-bar or belt-adjustment tool
Belt-driven unit
Belt

Procedure:	Evaluation			
	3	2	1	N
1. Put on safety glasses.	___	___	___	___
2. Disconnect power supply.	___	___	___	___
3. Remove belt guard/unit covers.	___	___	___	___
4. Inspect belt/check tension.	___	___	___	___
5. Loosen mounting bolts and free belt.	___	___	___	___
6. Place new belt on pulleys.	___	___	___	___
7. Tension belt and snug mounting bolts.	___	___	___	___
8. Adjust motor and driven unit until shafts are parallel.	___	___	___	___
9. Check and adjust pulley alignment.	___	___	___	___
10. Re-tighten mounting bolts.	___	___	___	___
11. Replace belt guards/unit covers.	___	___	___	___
12. Have instructor check your work.	___	___	___	___
13. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials.	___	___	___	___
Average of above evaluations*	___	___	___	___

***This average is the student's evaluation for competency G-2 of Building Maintenance.**

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 2: ELECTRIC MOTORS

LESSON OBJECTIVE

After completion of this lesson, the student will be able to IDENTIFY PARTS OF AN ELECTRIC MOTOR; DISASSEMBLE, CLEAN AND REASSEMBLE AN ELECTRIC MOTOR. Mastery will be evidenced by completion of the job sheet.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Identify the parts of an induction-run motor.
2. Name three factors to consider in selecting electric motors.
3. Determine factors to consider when replacing an electric motor.
4. Disassemble an electric motor.
5. Clean an electric motor.
6. Reassemble an electric motor.
7. Define name plate information for an electric motor.

Completion of the requirements of this lesson fulfills competency G-3 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 2: ELECTRIC MOTORS

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
  1. Parts of an induction-run motor
  2. Name plate information

G. Job sheet
  1. Clean an electric motor

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 2: ELECTRIC MOTORS

INFORMATION OUTLINE

I. Terms and definitions

  A. An induction-run motor runs by induced current and does not contain windings in the rotor

  B. A single-phase motor is one type available when one transformer between power supplier and customer is required

  C. The split-phase motor is used for easy starting loads and is the cheapest electric motor available

  D. The three-phase motor is used for difficult starting loads and is the most rugged and reliable type of motor

  E. The repulsion-start motor has windings in the rotor

  F. A capacitor-start motor has a capacitor in the starting windings

  G. Horsepower (hp)--a unit of power, numerically equal to a rate of 746 watts of electrical power

  H. Short circuit--when the connection between "hot" and "neutral" wires or between "hot" wires is incorrect

  I. Service factor--a multiplier indicating the amount of overload permitted for the motor

  J. RPM--number of revolutions a motor will turn per minute

  K. Automatic motor control--a switch or relay capable of responding to a device that senses variations in temperature, humidity, light and pressure

  L. Relay--a device capable of using a sensing signal to open and close a (switch) circuit

  M. Power factor--factor by which the volt-ampere product must be multiplied in order to obtain the actual power

N. Commutator--switch for reversing the direction of an electric motor

II. Single-phase, induction-run motors

A. Split-phase
1. Cheapest electric motor available
2. Available in sizes up to 1/3 hp
3. Works on a single phase power
4. Operates on 120- and/or 240-volt service
5. Used on easy-starting loads (grinders, saws, washing machines)

B. Repulsion-start
1. Uses single-phase power
2. Uses 102- and/or 240-volt service
3. Available in sizes for 1/6 to 10 hp
4. Used on hard-to-start loads

C. Capacitor-start, capacitor-run
1. Uses single-phase power
2. Has two capacitors
    a. One for starting
    b. One for running
3. Available in sizes of 5, 7 1/2, and 10 hp
4. USed on hard-to-start loads

D. Repulsion-start, capacitor-run
1. Uses single-phase power
2. A combination of the two motors listed above (Note: The capacitor helps maintain running efficiency after the motor reaches operating speed.)
3. Available in sizes of 1 to 15 hp

III. Parts of induction-run motor (TM 1)

A. Ventilated end bell or shield

B. Centrifugal starting switch

C. Thermal protection

D. Starter and frame

E. Sleeve bearing

F. Resilient mounting

G. Rotor and fans

H. Neoprene thrust washers

IV. Factors in selecting electric motors

A. Determine the type of electric power available

(Note: Single-phase or three-phase)

B. Determine the type and size of load

C. Determine conditions under which the motor must operate

V. Replacing electric motors

A. Horsepower rating must be the same or not more than one size larger

B. Full-load speed, cycles, duty, and base must be the same

C. Voltage 120 and/or 240

(Note: 240 voltage is preferred for 1/2 hp and larger)

D. Type should be the same

(Note: Type should be the same as the motor being replaced or a type having equal or greater starting torque)

VI. Name plate information

A. Type of current
  1. Alternating or direct
  2. Single-phase or three-phase

B. Type of overload protection

(Note: Thermalguard is a manufacturer's identification for a specific overload protection device built into the motor)

C. Hours that motor can be operated continuously

D. RPM--indicates the speed of the motor shaft

E. Horsepower

F. Volts

G. Temperature at which motor is to operate

H. Type of enclosure

I. Motor type

(Note: Manufacturers use different letters and symbols to identify different types of motors--the symbols (sp) split phase-start; (cs) capacitor-start; and (rs) repulsion-start are common)

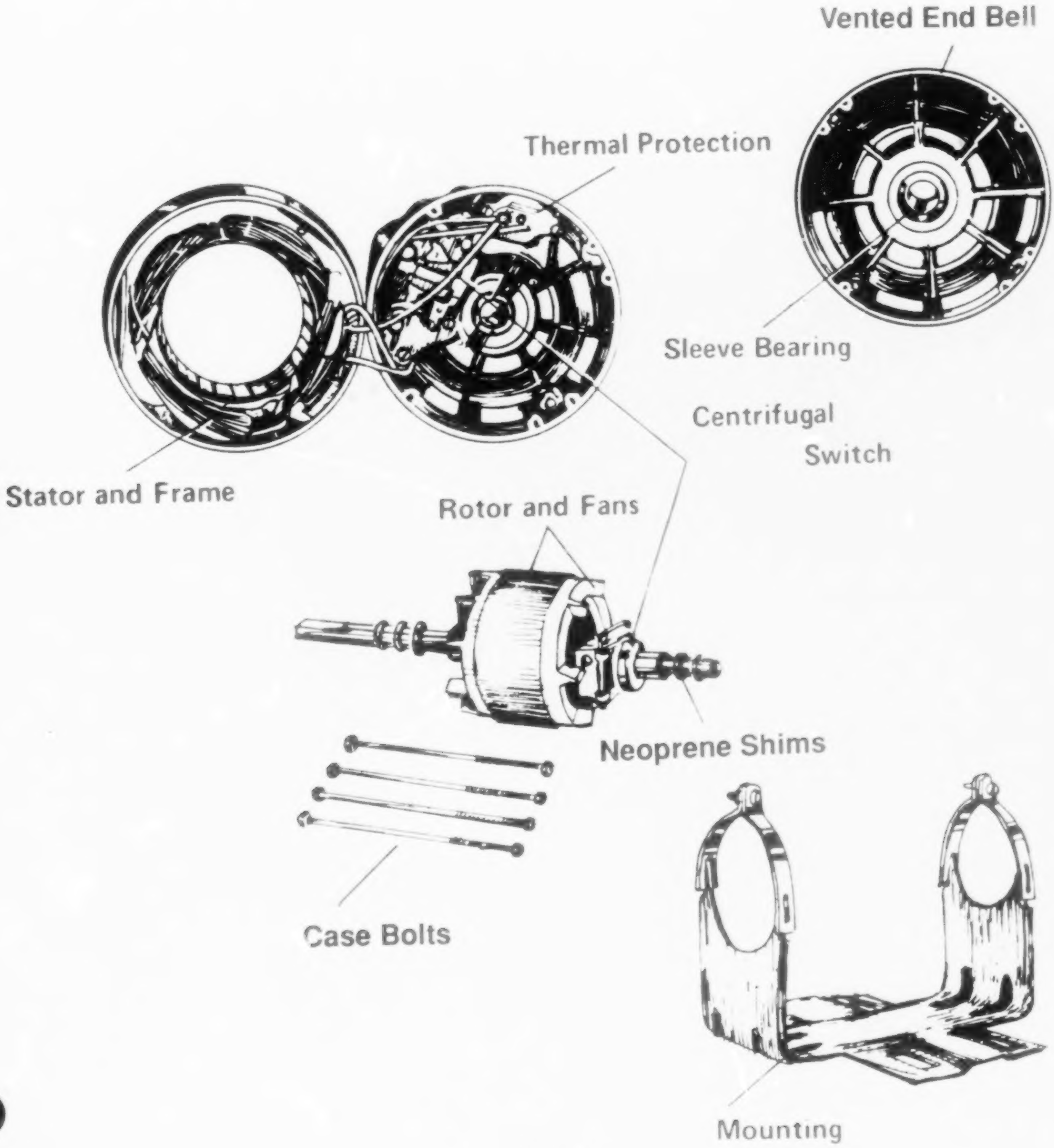
J. Type of frame

K. Cycle

L. Serial number

(Note: Use this number when writing to the manufacturer about a specific motor.)

PARTS OF AN INDUCTION-RUN MOTOR


Vented End Bell
Thermal Protection
Sleeve Bearing
Centrifugal Switch
Stator and Frame
Rotor and Fans
Neoprene Shims
Case Bolts
Mounting

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 3: CLEAN AND/OR REPLACE HEATING ELEMENTS--GAS

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Job sheet
  1. Clean and/or replace heating elements--gas

E. Lesson test

F. Answers to lesson test

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 3: CLEAN AND/OR REPLACE HEATING ELEMENTS--GAS

INFORMATION OUTLINE

I. Terms and definitions

  A. Burner--a gas fired heating element

  B. Crossover--an inverted channel for the transfer of fuel gas to the pilot

  C. Burner ports--openings along the top of the burner where gas is allowed to escape for burning

  D. Air Shutter--adjustable closure at the front end of a burner for control of fuel air mixture (L.P.G. only)

  E. Manifold--burner fuel supply pipe

  F. Orifice--a properly sized opening through which fuel enters the burner from the manifold

II. Burner Flame--Fire burners by setting room thermostat at a higher setting than room temperature--allow burner to operate for a few minutes in order to establish normal burning conditions

  A. Check burner flame by observation

  B. Flame should be predominately blue in color and strong in appearance

  C. Flame should be continuous along the burner

  D. Flame should rise directly from the burner into the heat exchanger

III. Cleaning Burner

  A. Turn off all gas and electrical supplies before attempting to service burners

  B. Remove each burner by lifting it from its receiving slot at the rear of the heat exchanger, push away until burner clears the orifice at the near end and guide it out of the furnace

C. The top of the burner may be cleaned with a wire brush and a tool may be made from a piece of sheet metal for cleaning the burner ports--work the tool in and out of each port until clear

D. Clean the inside of the burner with a bottle brush

E. Replace each burner by reversing the removal process making certain to fully engage it in the rear receiving slots in the heat exchanger

F. Check for proper alignment of the pilot crossover ignitor piece

IV. Lighting Furnace

A. After all assembly is complete and all covers are in place, turn on gas and electrical supplies and check for gas leaks

B. Following the unit instructions, light pilot--after pilot is secured, again set room thermostat at a higher than room temperature and observe burner operation

(Note: If the odor of gas is present, do not attempt lighting until the source of the problem is found and corrected)

CLEAN AND/OR REPLACE HEATING ELEMENTS--GAS

Equipment:

Safety Glasses
Service tool pouch
Wire brush
Port cleaning tool (sheet metal)
Bottle brush
Furnace

Procedure:	Evaluation 3	2	1	N
1. Turn off all electrical and gas supplies to the furnace.	___	___	___	___
2. Remove access panels.	___	___	___	___
3. Remove burner.	___	___	___	___
4. Clean burner.	___	___	___	___
5. Replace burner.	___	___	___	___
6. Replace panels.	___	___	___	___
7. Restore gas supply and check for leaks. Caution: Do not operate electrical switches or try to light pilot if the odor of gas is present!	___	___	___	___
8. Restore electrical supply.	___	___	___	___
9. Light pilot following unit instructions.	___	___	___	___
10. Set room thermostat and observe burner ignition and operation.	___	___	___	___
11. Have instructor inspect work.	___	___	___	___
12. As directed by instructor, prepare for next assignment or clean work area and return tools.	___	___	___	___
Average of above evaluations*	___	___	___	___

This average is the evaluation for competency G-5 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 3: CLEAN AND/OR REPLACE HEATING ELEMENTS--GAS

LESSON TEST

Part 1. Match terms and definitions associated with gas heating elements. Place the letter of the proper term in the blank at the beginning of each definition.

A. Burner

B. Manifold

C. Burner ports

D. Orifice

E. Air shutter

F. Crossover

1._______ Openings along top of burner

2._______ Inverted channel for fuel transfer to pilot

3._______ Adjustable fuel/air mixture control for L.P.G. burners

4._______ Burner fuel supply pipe

5._______ A gas fired heating element

6._______ A sized opening through which fuel enters the burner

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

ANSWERS TO UNIT II, LESSON 3 TEST

Part 1.

1. C
2. F
3. E
4. B
5. A
6. D

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 4: CLEAN AND/OR REPLACE HEATING ELEMENTS--ELECTRIC

LESSON OBJECTIVE

After completion of this lesson, the student will be able to CLEAN ELECTRIC HEATING ELEMENTS AND RECOGNIZE CONDITIONS REQUIRING REPLACEMENT AND THEN REMOVE OR REPLACE ELEMENTS. Mastery will be evidenced by completion of the job sheet.

SPECIFIC OBJECTIVES

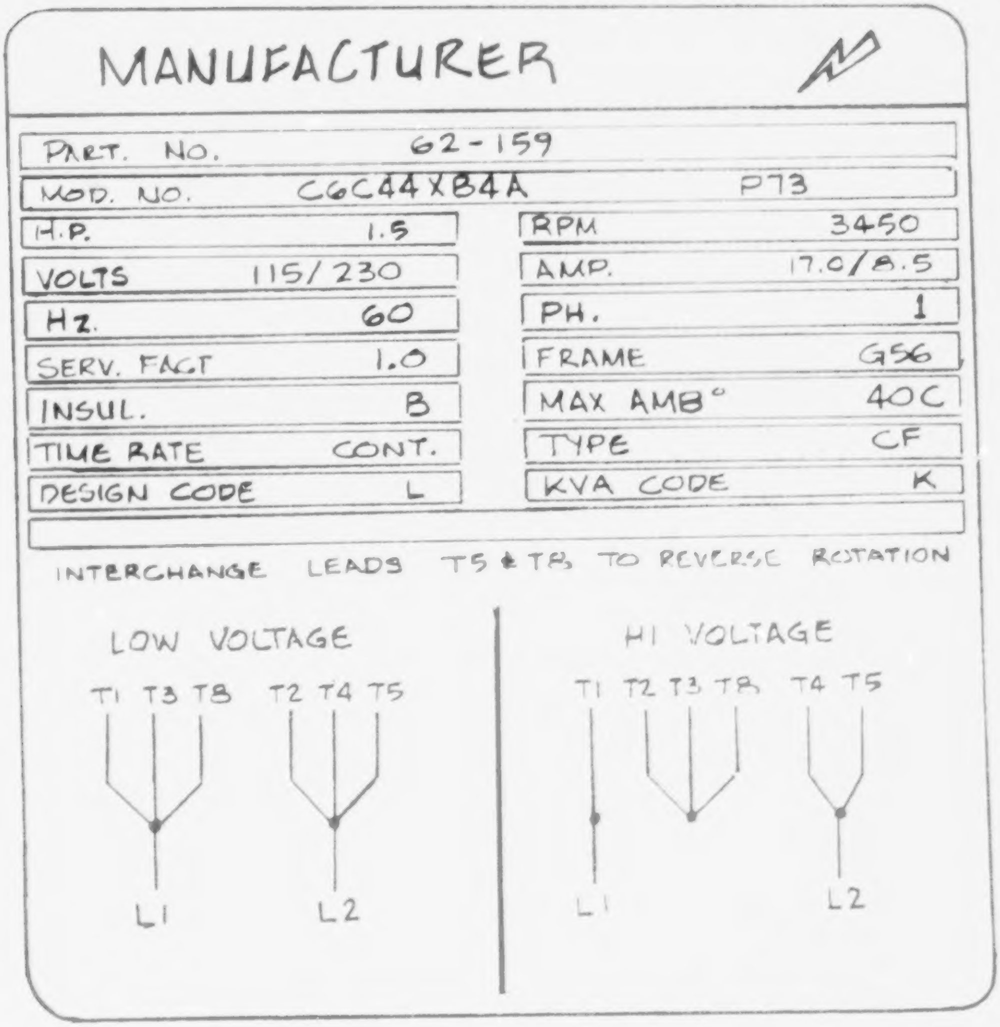
In completing this lesson, the student will:

1. Identify terms associated with electric elements.
2. Identify proper operation of electric heating elements.
3. Remove/clean/replace electric heating elements.

   Note: Completion of Unit I, Lesson 6 (Using Electronic Test Equipment) required before attempting this lesson.

Completion of the requirements of this lesson partially fulfills competency G-5 of Building Maintenance.

MOTOR NAME PLATE INFORMATION



MANUFACTURER

PART. NO.	62-159		
MOD. NO.	C6C44XB4A		P73
H.P.	1.5	RPM	3450
VOLTS	115/230	AMP.	17.0/8.5
Hz.	60	PH.	1
SERV. FACT	1.0	FRAME	G56
INSUL.	B	MAX AMB°	40C
TIME RATE	CONT.	TYPE	CF
DESIGN CODE	L	KVA CODE	K

INTERCHANGE LEADS T5 & T8 TO REVERSE ROTATION

LOW VOLTAGE
T1 T3 T8
T2 T4 T5
L1
L2
HI VOLTAGE
T1
T2 T3 T8
T4 T5
L1
L2

CLEAN ELECTRIC MOTORS

Equipment:

Motor
Adjustable wrench
Air supply
Ball pein hammer
Soft-faced mallet
Clean lintless rags
Screwdriver
220 Grit paper (no emery cloth)
Center punch
1/4 drive socket set
Cleaning fluid (non-flammable)
Electric motor oil

Procedure:

Evaluation
3 2 1 N

1. Disconnect motor. ___ ___ ___ ___

2. Remove motor from mounting. ___ ___ ___ ___

   (Note: Record position of wires on motor terminals for replacement.)

3. Clean surface of motor. ___ ___ ___ ___

4. Remove pulley. ___ ___ ___ ___

5. Take the center punch and hammer and put one mark on end bell at the pulley end and then two marks on the other end bell. ___ ___ ___ ___

6. Mark housing the same way end bells were marked. ___ ___ ___ ___

7. Remove case bolts and tap end bells loose with screwdriver and soft mallet. ___ ___ ___ ___

8. Remove end bell opposite the starting switch or brush ring. ___ ___ ___ ___

   (Note: Record position and number of shims on the shaft as end bells are removed.)

9. Remove end bell containing switch. ___ ___ ___ ___

10. Clean contacts using fine grit paper. ___ ___ ___ ___

11. Clean parts with cleaning fluid. ___ ___ ___ ___

    (Note: Keep fluid off wiring and dry parts with air supply.)

12. Clean bearings and check wick. ___ ___ ___ ___

14. Replace end bell containing switch. ___ ___ ___ ___

15. Insert rotor. ___ ___ ___ ___

    (Note: Check location of shims and place a drop of oil on the bearing part of shaft.)

16. Position end bells with punch marks. ___ ___ ___ ___

17. Tap end bells into place with soft mallet. ___ ___ ___ ___

18. Replace case bolts and tighten. ___ ___ ___ ___

    (Note: Turn shaft by hand, if it does not turn freely, check end bells for alignment and check for wicking between bearing and shaft.)

19. Connect motor to temporary power supply and test. ___ ___ ___ ___

20. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

This average is the student's evaluation for competency G-3 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 3: CLEAN AND/OR REPLACE HEATING ELEMENTS--GAS

LESSON OBJECTIVE

After completion of this lesson, the student will be able to RECOGNIZE CONDITIONS REQUIRING SERVICE/REPLACEMENT and REMOVE/CLEAN/REPLACE GAS HEATING ELEMENTS. Mastery will be evidenced by completion of the job sheet(s) and by scoring ____________ percent or higher on the lesson test.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Identify safe gas appliance servicing practices.
2. Identify components of gas appliances.
3. Identify proper burner ignition/operation.
4. Remove/clean/replace burner.
5. Identify terms associated with gas appliances.

Completion of the requirements of this lesson partially fulfills competency G-5 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 4: CLEAN AND/OR REPLACE HEATING ELEMENTS--ELECTRIC

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency Master
  1. Electric Heating Elements

D. Job Sheet
  1. Clean and/or Replace Electric Heating Elements

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 4: CLEAN AND/OR REPLACE HEATING ELEMENTS--ELECTRIC

INFORMATION OUTLINE

I. Terms and definitions

  A. Resistance heating element--lengths of metal material that gives off heat as a result of electrical current flowing through it

  B. Open wire element--wire element directly exposed in the air stream--usually loosely coiled along its length (similar to a spring)

  C. Open ribbon element--flat length of metal expanded into a meshlike form and placed in a ribbon effect, directly exposed in the air stream--provides good surface to air contact

  D. Tubular cased wire element--resistance wire surrounded by magnesium oxide powder encased in a heat and corrosion resistant steel tube--these are sometimes placed in fin-type aluminum castings to increase surface to air contact

II. Element inspection/cleaning/replacement

  A. Turn off all electrical power supplies to the unit

  B. Remove cover/access panels

  C. Using volt meter, verify power disconnection

  D. Disconnect wiring from element terminals for proper reconnection

  E. Use an OHM-meter to test element(s) for resistance and continuity

  F. Remove element mounting screws and pull element(s) from unit

  G. Carefully inspect the element(s) along the entire length for breaks--if broken, element must be replaced

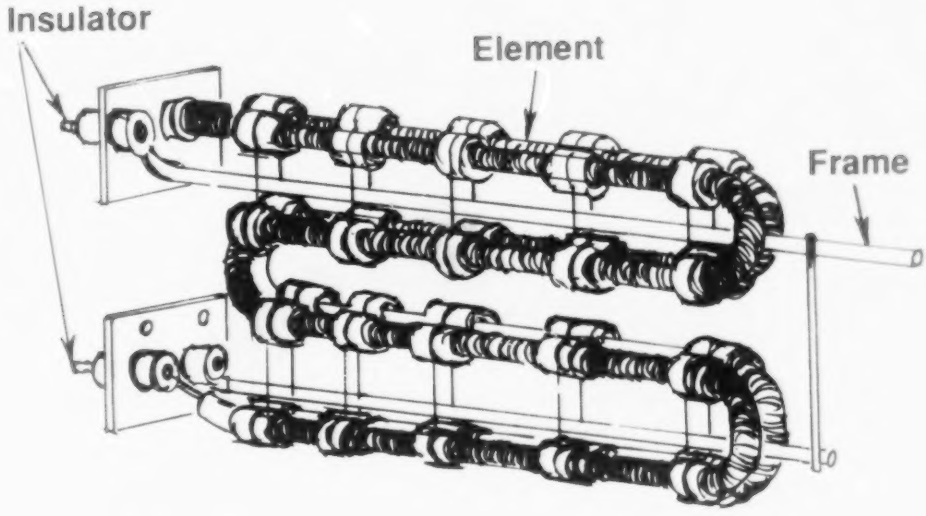
  H. When replacing an element, care must be exercised--"do not" kink the element as kinks cause hot spots that will soon burn--causing a break

I. Dust and lint may be removed with a dry soft cloth or soft bristle brush (care should be exercised)

J. Replace all components in their original places and reconnect wiring making all connections tight

K. Replace covers/access panels, restore electrical power and verify proper unit operation

Heater Coils and Rack


Insulator
Element
Frame

JS 1

CLEAN AND/OR REPLACE HEATING ELEMENTS--ELECTRIC

Equipment:

Safety glasses
Service tool pouch
Soft dry cloth or soft bristle brush
Volt/OHM meter
Electric heat unit

Procedure:

Evaluation
3 2 1 N

1. Turn off all electrical supplies to unit. ___ ___ ___ ___

2. Remove access panels. ___ ___ ___ ___

3. Verify disconnection with volt meter. ___ ___ ___ ___

4. Disconnect wiring from element(s). ___ ___ ___ ___

   (Note: Label wire and terminals for reconnection.)

5. Use OHM meter to check for resistance and continuity. ___ ___ ___ ___

6. Remove element from unit and inspect for breaks. ___ ___ ___ ___

7. Replace broken element and any broken insulators or mountings. ___ ___ ___ ___

   (Note: DO NOT kink the element(s).)

8. Replace element in unit and reconnect wiring to terminals. ___ ___ ___ ___

9. Replace access panels and restore electrical power to unit. ___ ___ ___ ___

10. Set room thermostat to higher than room temperature and check unit for proper operation. ___ ___ ___ ___

11. Have instructor check your work. ___ ___ ___ ___

12. As directed by instructor, prepare for next job sheet or clean up area and return tools and materials. ___ ___ ___ ___

Average of above evaluations* ___ ___ ___ ___

***This average is the student's partial evaluation for competency G-5 of Building Maintenance.**

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 5: CLEAN CONDENSING UNIT

LESSON OBJECTIVE

After completion of this lesson, the student will be able to CLEAN A CONDENSING UNIT. Mastery will be evidenced by completion of the job sheet.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Identify safe condensing unit cleaning practices.
2. Clean a condensing unit.

Completion of the requirements of this lesson fulfills competency G-6 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 5: CLEAN CONDENSING UNIT

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency master
   1. Outdoor condensing unit(s)

D. Job sheet
   1. Cleaning condensing unit

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 5: CLEAN CONDENSING UNIT

INFORMATION OUTLINE

I. Cleaning a condensing unit

   A. A condensing coil of a cooling unit is the coil located in the outdoor air stream

   B. If the coil becomes dirty or restricted, air flow will be restricted causing reduced efficiency

   C. Disconnect all electrical power from the unit before attempting to clean the coil

   D. Remove panels and guard screens

   E. Clean leaves and grass clippings from coil

   F. If coil slabs are double, separate at one end and clean between slabs

   G. Coils may be flushed with water from a hose taking care not to wet the electrical components or damage the coil fins

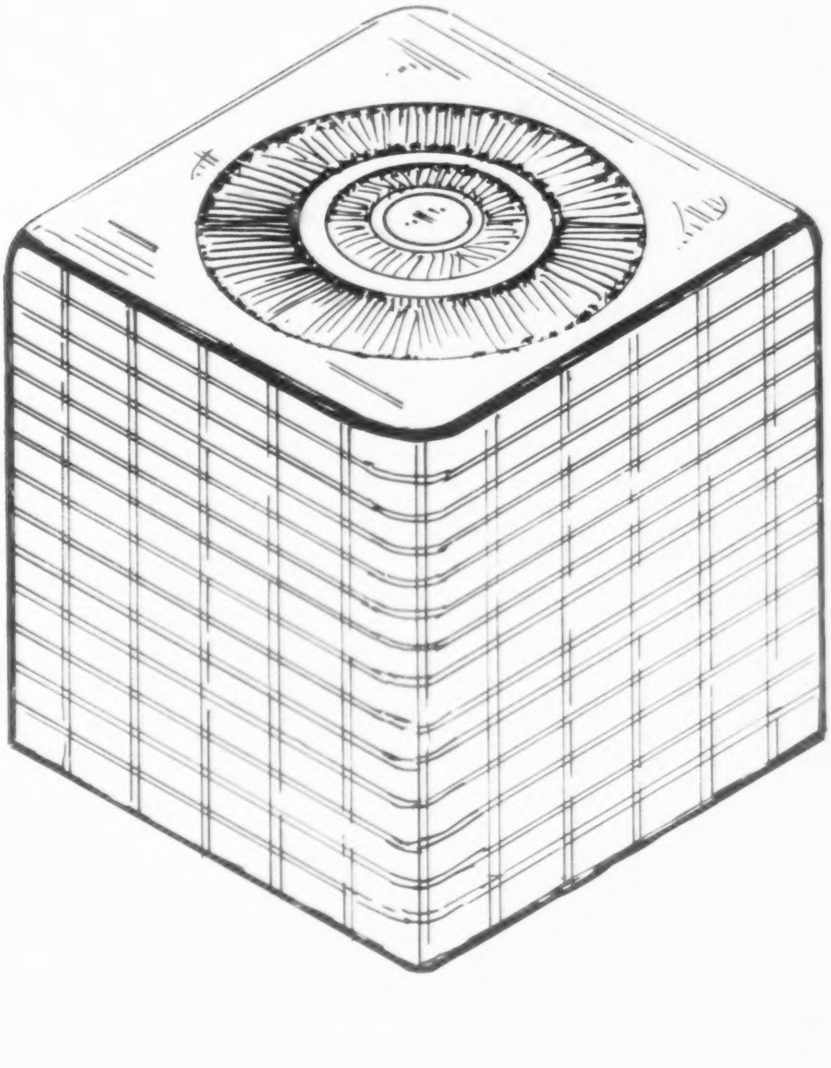
   H. If further cleaning is needed, spray the condenser coil with detergent or a commercial condenser coil cleanser

   I. Rinse well with water after cleaning

   J. Inspect coil for damaged fins and straighten so that air may flow easily over them

   K. Be sure all electrical components are dry and panel/guards are in place before restarting unit

Outdoor Condensing Unit



CLEAN CONDENSING UNIT

Equipment:

Safety glasses
Rubber gloves
Spray/cleanser/detergent
Water supply and hose
Service tool pouch
Fin tool
Condensing unit

Procedure:	Evaluation			
	3	2	1	N
1. Disconnect all electrical power from unit.				
2. Remove panels/screen guards from unit.				
3. Remove clips and separate coil slabs.				
4. Flush with water.				
5. Spray with cleaning agent if needed.				
6. Rinse well with water.				
7. Reassemble coil slabs.				
8. Inspect fins and straighten as required.				
9. Dry all electrical components and replace panels and screens before restarting unit.				
10. Have instructor check your work.				
11. Turn on unit power.				
12. As directed by instructor, prepare for next assignment or clean and return tools.				
Average of above evaluations*				

This average is the student's evaluation for competency G-6 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 6: CLEAN EVAPORATOR COIL

LESSON OBJECTIVE

After completion of this lesson, the student will be able to CLEAN AN EVAPORATOR COIL. Mastery will be evidenced by completion of the job sheet.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Identify safe coil cleaning practices.
2. Clean evaporator coil.

Completion of the requirements of this lesson fulfills competency G-7 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 6: CLEAN EVAPORATOR COIL

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency master
   1. Evaporator coil

D. Job sheet
   1. Clean an evaporator coil

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 6: CLEAN EVAPORATOR COIL

INFORMATION OUTLINE

I. Cleaning an evaporator coil

  A. An evaporator coil is the cooling coil and is located in the indoor air stream

  B. If the coil becomes dirty, air flow will be restricted causing reduced efficiency

  C. Disconnect all electrical power from the unit before accessing the cooling coil

  D. Cutting into the ductwork may be necessary since not all units have access panels at the evaporator

  E. When cutting ductwork, make provisions for reclosing the duct

  F. Be cautious of the evaporator inside the duct and do not damage the coil or the refrigeration lines attached to it

  G. Protect the eyes and skin from any cleaning solution being used

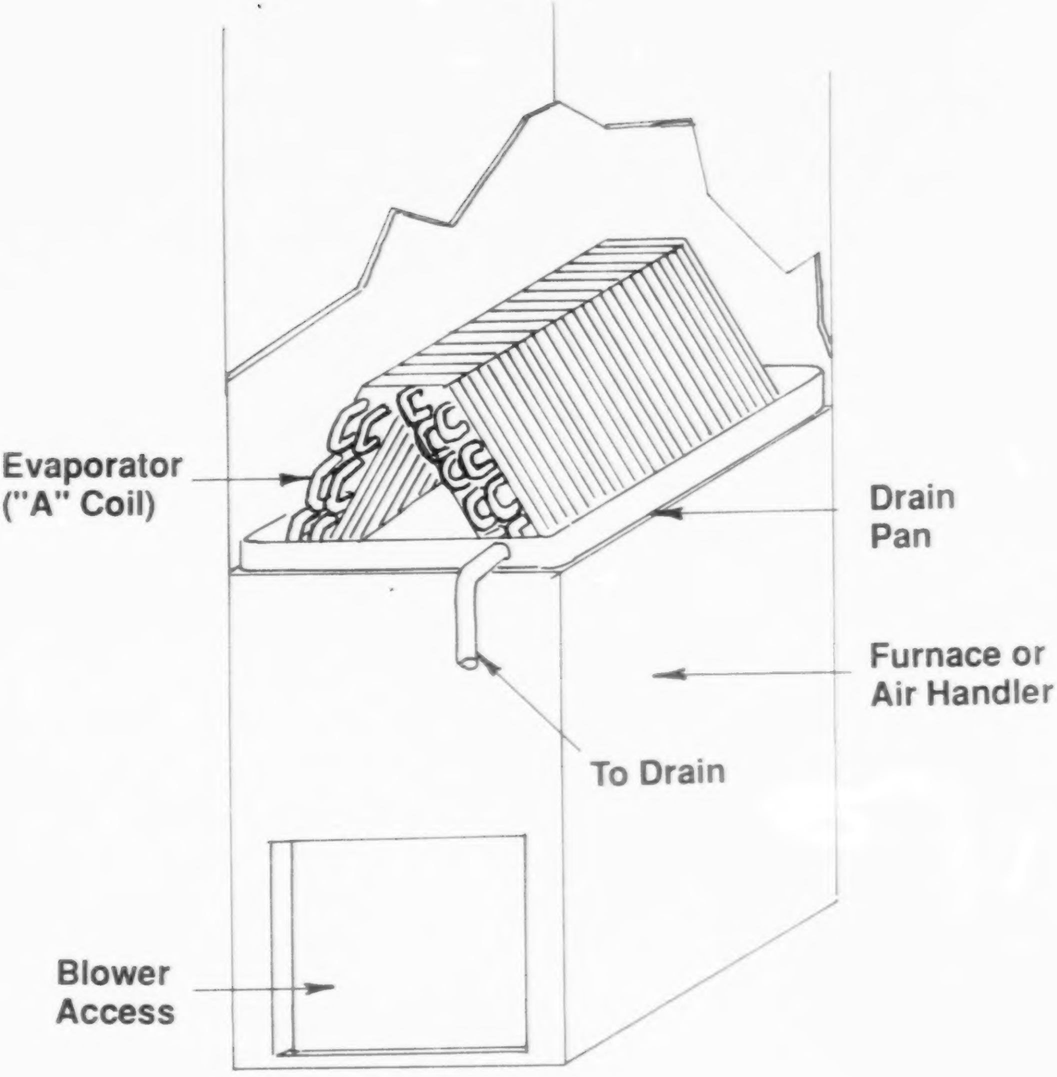
  H. Clean coil by using a spray of water and mild detergent or a commercial coil cleanser

  I. Flush coil and condensate drain with water until free of cleansing product--take care not to get the filters, return duct, or unit insulation wet

  J. Inspect the coil for bent or damaged fins--straighten fins carefully so that air may flow easily over them

  K. Patch ductwork/replace panels being careful to seal all openings

Evaporator Coils


Evaporator
("A" Coil)
Drain
Pan
Furnace or
Air Handler
To Drain
Blower
Access

Evaporator coils may be "A" coils as shown, "flat" across the air stream or "slanted" across the air stream.

JS 1

CLEAN AN EVAPORATOR COIL

Equipment:

Safety glasses
Rubber gloves
Service tool pouch
Wiping towels
Inspection mirror
Evaporator
Spray/cleanser/detergent
Sheet metal tools
Portable light
Fin tool

Procedure:	Evaluation 3	 2	 1	 N
1. Turn off power to the unit.	___	___	___	___
2. Remove access panel or cut into duct.	___	___	___	___
3. Inspect coil.	___	___	___	___
4. Clean coil and rinse.	___	___	___	___
5. Straighten fins as needed.	___	___	___	___
6. Replace access panel/repair duct.	___	___	___	___
7. Clean up unit and area.	___	___	___	___
8. Have instructor inspect work.	___	___	___	___
9. Turn on unit power.	___	___	___	___
10. As directed by instructor, prepare for next assignment or clean and return tools.	___	___	___	___
Average of above evaluations*	___	___	___	___

This average is the evaluation for competency G-7 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 7: CHECK AND CLEAN FLUES

LESSON OBJECTIVE

After completion of this lesson, the student will be able to IDENTIFY THE NEED FOR and CLEAN A FLUE AND HEAT EXCHANGER. Mastery will be evidenced by completion of the job sheets.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Identify safe practices.
2. Identify the need for cleaning a flue and heat exchanger.
3. Clean a flue.
4. Clean a heat exchanger.

Completion of the requirements of this lesson fulfills competency G-9 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 7: CHECK AND CLEAN FLUES

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
  1. Chimney sweep brushes
  2. Cleaning a heat exchanger

D. Job sheets
  1. Check and clean a building flue
  2. Check and clean a heat exchanger

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 7: CHECK AND CLEAN FLUES

INFORMATION OUTLINE

I. Checking and cleaning flues

   A. A flue is the passageway for spent gasses to exit the furnace--these gasses must also exit the building through a flue (chimney)--the unit (furnace) flue is also the heat exchanger

   B. A flue should be checked periodically for the build up of soot--soot is a black substance (carbon) resulting from fuel combustion and may cause blockage of flue passages

   C. Blockage of flues will cause improper furnace operation and more seriously, sickness or death to the building occupants

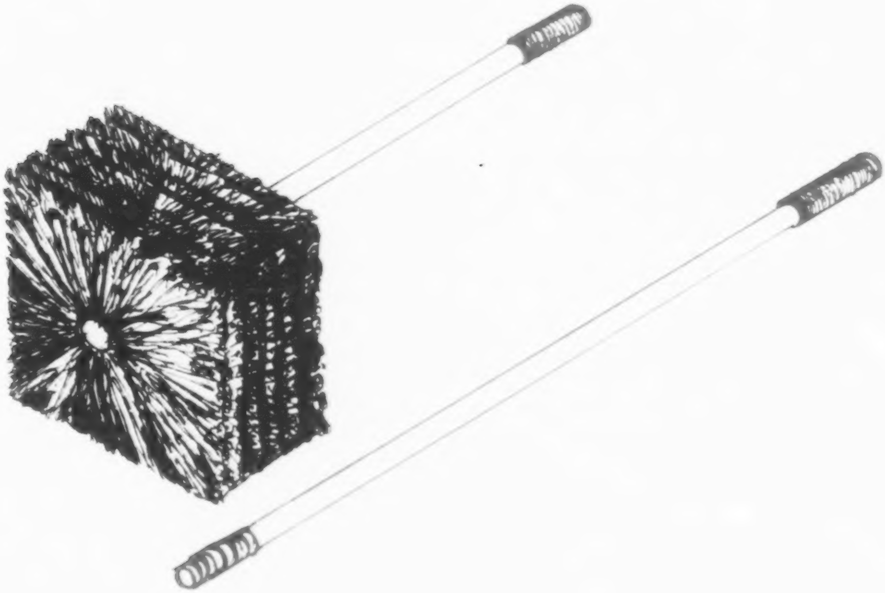
   D. Use proper ladder safety when accessing a flue or a roof

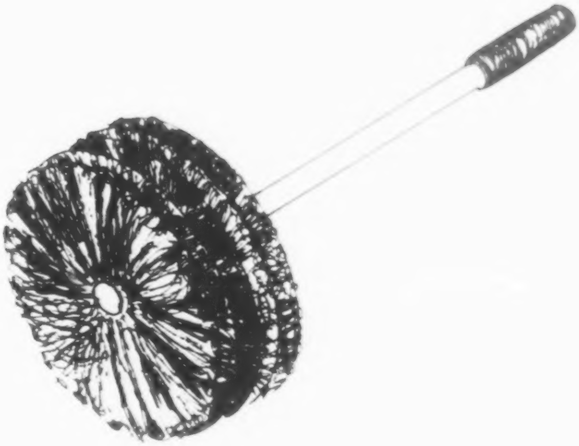
   E. Be sure all fuel and electrical supplies are turned off

   F. Provide protection for contents of the building when cleaning a flue as soot is very difficult to clean from carpets, curtains, furniture, etc

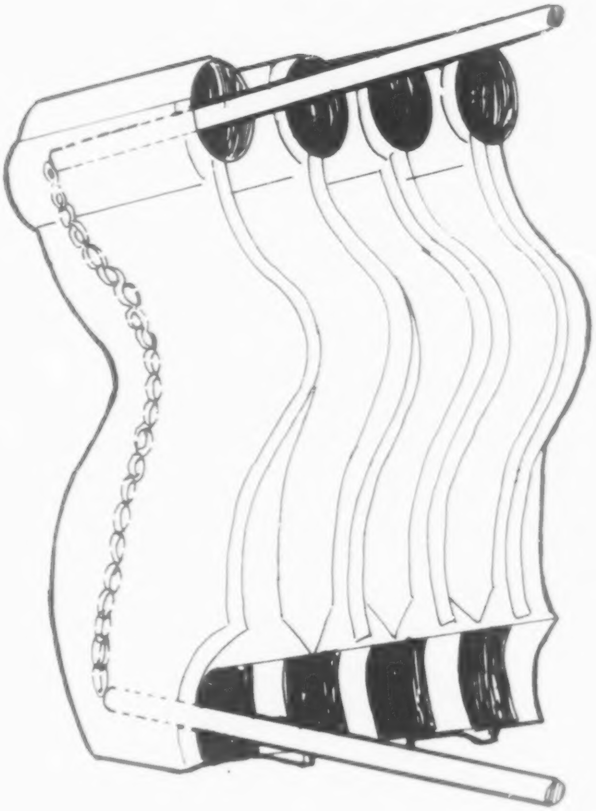
   G. Wear proper personal safety equipment, safety glasses and dust mask or respirator

Chimney Sweep Brushes





Cleaning a Heat Exchanger



CHECK AND CLEAN A BUILDING FLUE

Equipment:

- Safety glasses
- Dust mask/respirator
- Ladder
- Drop cloth(s)
- Trash bag(s)
- Chimney brushes/extensions
- Portable light
- Inspection mirror
- Chimney
- Service tool pouch
- Vacuum

Procedure:	Evaluation			
	3	2	1	N
1. Turn off fuel and electrical supplies.	___	___	___	___
2. Remove upper access panel (if used, remove induced draft blower.)	___	___	___	___
3. Distribute drop cloths to protect surroundings.	___	___	___	___
4. Hang trash bag below flue opening.	___	___	___	___
5. Set ladder and access roof/chimney.	___	___	___	___
6. Inspect chimney using light/mirror (this may also be done from furnace.)	___	___	___	___
7. Attach extension to brush and insert in chimney.	___	___	___	___
8. Move brush up and down as needed, attach additional extensions.	___	___	___	___
9. When clean, remove extensions as brush is pulled from chimney.	___	___	___	___
10. Clean up both roof and furnace areas.	___	___	___	___
11. Replace furnace parts/panels.	___	___	___	___
12. Have instructor inspect work.	___	___	___	___
13. As directed by instructor, prepare for next assignment or clean and return tools.	___	___	___	___
Average of above evaluations*	___	___	___	___

***This average is the student's evaluation for competency G-9 of Building Maintenance.**

JS 2

CHECK AND CLEAN A HEAT EXCHANGER

Equipment:

Safety glasses
Drop cloth
Vacuum
Small chain (2 ft.)
Portable light
Furnace
Dust mask/respirator
Trash bag
Rods (2)
Service tool pouch
Inspection mirror

Procedure:	Evaluation			
	3	2	1	N
1. Turn off fuel and electrical supplies.				
2. Remove upper access panel (if used, remove induced draft blower).				
3. Distribute drop cloths to protect surroundings.				
4. Remove burner assembly (other parts if necessary).				
5. Attach chain to end of one rod and insert into top opening of heat exchanger.				
6. Shake the rod so that the chain will drop through the heat exchanger and attach second rod to bottom of chain.				
7. Using a vigorous motion, push and pull rods and chain back and forth and up and down so that the chain will dislodge soot and scale.				
8. Repeat for each heat exchanger.				
9. Use light/mirror to inspect heat exchanger.				
10. Clean furnace and surrounding area.				
11. Replace furnace parts and panels.				
12. Have instructor check work.				
13. As directed by instructor, prepare for next assignment or clean and return tools.				
Average of above evaluations*				

***This average is the student's evaluation for competency G-9 of Building Maintenance.**

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 8: REPLACE A FURNACE AND COOLING FILTER

LESSON OBJECTIVE

After completion of this lesson, the student will be able to IDENTIFY THE NEED FOR and REPLACE A FURNACE OR COOLING FILTER. Mastery will be evidenced by completion of the job sheets.

SPECIFIC OBJECTIVES

In completing this lesson, the student will:

1. Identify safety practices for replacing furnace or cooling filter.
2. Identify the need for replacing furnace or cooling filter.
3. Change filters.

Completion of the requirements of this lesson fulfills competency G-10 of Building Maintenance.

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 8: REPLACE A FURNACE AND COOLING FILTER

CONTENTS OF LESSON

A. Objectives

B. Information outline

C. Transparency masters
  1. Frame with throw-away media
  2. Frame with washable media

D. Job sheet
  1. Replace a furnace or cooling filter

MODULE: ELECTRICAL PROCEDURES AND ENVIRONMENTAL CONTROL SYSTEMS

UNIT II: SERVICING ENVIRONMENTAL CONTROL SYSTEMS

LESSON 8: REPLACE A FURNACE AND COOLING FILTER

INFORMATION OUTLINE

I. When to replace a filter

   A. Filters must be replaced when dirty to assure proper unit operation

   B. In order to safely access filter, turn off electrical power to the unit and wait until after the blower has stopped

II. Procedure

   A. Prior to accessing the unit, determine the type and size of filter required and have on hand

   B. Access filter by removing access panel

   C. Remove entire filter assembly from unit

   D. Inspect, clean/replace filter

   E. Return filter assembly to unit and replace access panel

III. Types of filter assemblies

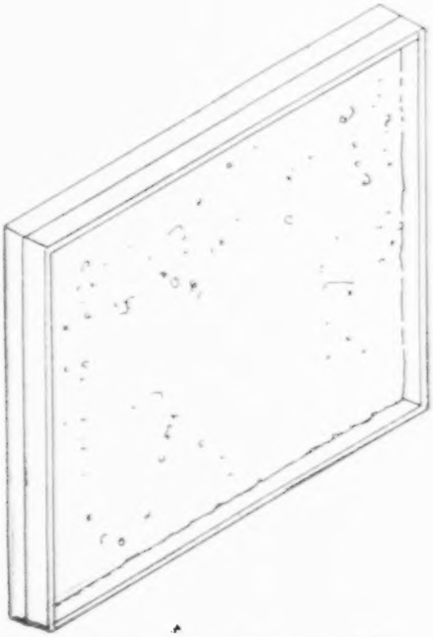
   A. Throw-away assembly

   B. Frame with throw-away media

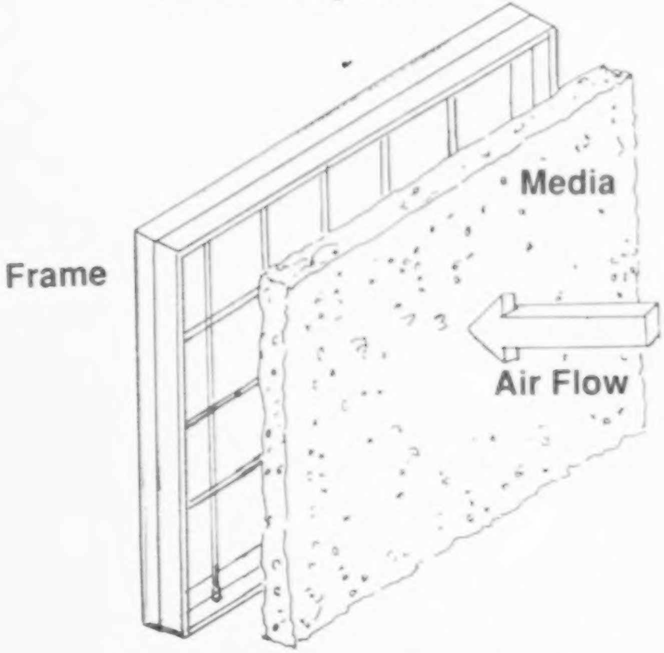
   C. Washable assembly

   D. Frame with washable media

Types of Filter Assemblies



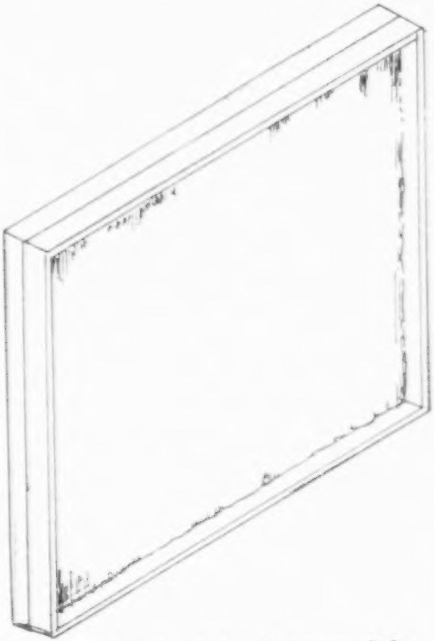
Throw-away Assembly


Media
Frame
Air Flow

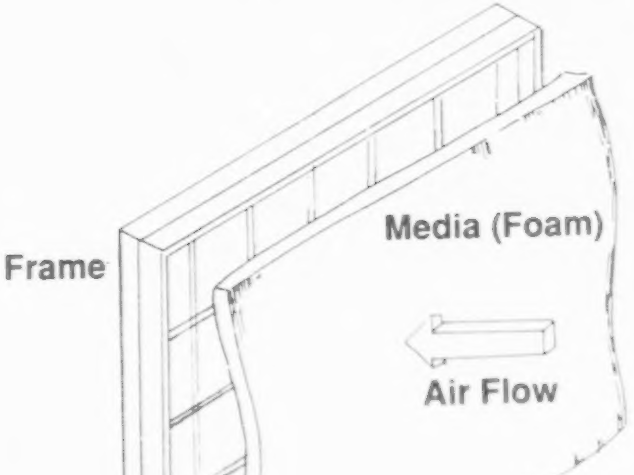
Frame with Throw-away Media

TM 2

Types of Filter Assemblies



Washable Assembly


Media (Foam)
Frame
Air Flow

Frame with Washable Media

REPLACE A FURNACE OR COOLING FILTER

Equipment:

Safety glasses
Utility knife
Filter/media/assembly
Screwdriver/nut driver
Furnace/cooling unit

Procedure:	Evaluation 3	 2	 1	 N
1. Turn off electrical power.				
2. Remove access panel.				
3. Remove filter assembly.				
4. Inspect filter.				
5. Replace/wash filter.				
6. Return assembly to unit.				
7. Replace access panel.				
8. Restore electrical power.				
9. Have instructor check work.				
10. As directed by instructor, prepare for next assignment or clean up work area and return tools and materials.				
Average of above evaluations*				

*This average is the student's evaluation for competency G-10 of Building Maintenance.